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MDCCCXLII.

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But the Society being of late years greatly enlarged, and their communications more numerous, it was thought advisable that a Committee of their members should be appointed, to reconsider the papers read before them, and select out of them such as they should judge most proper for publication in the future *Transactions*; which was accordingly done upon the 26th of March 1752. And the grounds of their choice are, and will continue to be, the importance and singularity of the subjects, or the advantageous manner of treating them; without pretending to answer for the certainty of the facts, or propriety of the reasonings, contained in the several papers so published, which must still rest on the credit or judgement of their respective authors.

It is likewise necessary on this occasion to remark, that it is an established rule of the Society, to which they will always adhere, never to give their opinion, as a Body,

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upon any subject, either of Nature or Art, that comes before them. And therefore the thanks, which are frequently proposed from the Chair, to be given to the authors of such papers as are read at their accustomed meetings, or to the persons through whose hands they received them, are to be considered in no other light than as a matter of civility, in return for the respect shown to the Society by those communications. The like also is to be said with regard to the several projects, inventions, and curiosities of various kinds, which are often exhibited to the Society; the authors whereof, or those who exhibit them, frequently take the liberty to report and even to certify in the public newspapers, that they have met with the highest applause and approbation. And therefore it is hoped that no regard will hereafter be paid to such reports and public notices; which in some instances have been too lightly credited, to the dishonour of the Society.

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That the Royal Medals be given for such papers only as have been presented to the Royal Society, and inserted in their Transactions.

That the triennial Cycle of subjects be the same as that hitherto in operation: viz.

1. Astronomy; Physiology, including the Natural History of Organized Beings.
2. Physics; Geology or Mineralogy.
3. Mathematics; Chemistry.

That, in case no paper, coming within these stipulations, should be considered deserving of the Royal Medal, in any given year, the Council have the power of awarding such Medal to the author of any other paper on either of the several subjects forming the Cycle, that may have been presented to the Society and inserted in their Transactions; preference being given to the subjects of the year immediately preceding: the award being, in such case, subject to the approbation of Her Majesty.

The Council propose to give one of the Royal Medals in the year 1842 for the most important unpublished paper in Astronomy, communicated to the Royal Society for insertion in their Transactions after the termination of the Session in June 1839, and prior to the termination of the Session in June 1842.

The Council propose also to give one of the Royal Medals in the year 1842 for the most important unpublished paper in Physiology, including the Natural History of

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PHILOSOPHICAL TRANSACTIONS.

I. *On the Laws of the Rise and Fall of the Tide in the River Thames.*

By G. B. Airy, *Esq., M.A., F.R.S., Astronomer Royal.*

Received July 3,—Read November 25, 1841.

In the winter of 1840–1841, an extensive series of observations of tides was made, in accordance with my suggestions, at Deptford Royal Victualling Yard. For these observations, as well as for those which follow (and which form more immediately the subject of this paper), I am indebted to Captain Shirreff, R.N., Captain Superintendent of the Royal Victualling Yard and Dock Yard at Deptford. By the kindness of this able officer, I was allowed to give such directions to the police constables on duty in the Victualling Yard as I thought necessary for my purpose; and by his continual superintendence of the observations, I was able to satisfy myself that they were conducted exactly as I desired, and were worthy of the fullest confidence. I cannot adequately express my sense of the attention which thus put me in possession of the data that I desired, and in the very form in which I desired them, without the smallest trouble to me in the whole transaction.

The mode of making the observations was the following. Under the direction of Captain Shirreff, a vertical scale of feet and inches was marked on the return of the wharf-wall adjoining to the principal landing-stairs of the Victualling Yard. The graduations increased in going downwards, the top of the wharf-wall being the zero. As the bottom of this return of the wall was sometimes dry at low water, a level line was carried to the extremity of the causeway at the bottom of the principal stairs, and another vertical scale (in continuation of the former) was measured there. Thus every observation of the surface of the water was a measure of its depression below the top of the wharf-wall. The times of the observations were in all cases the quarters of hours of mean solar time, as indicated by the striking of the clock of the Victualling Yard. It is proper to mention, that, in consequence of the extensive visibility of the signal-ball of the Royal Observatory (which is dropped at 1^h P.M. precisely), the public clocks in the neighbourhood of Greenwich are for the most part extremely well regulated; and I have therefore little doubt that the times of observation are pretty accurately those which they profess to be.

The object of the first series of observations was simply to ascertain the times of

high and low water, for the purpose of ascertaining the durations of the rise and fall of the tide. With this view, the depression of the water below the wharf was observed at the four quarters-of-hour nearest to the time of high water, and at the seven quarters-of-hour nearest to the time of low water (a greater number of observations being made near low water, because less is known, from other observations, of the time of low water). And I proposed, by combining the observations of each group, to find the times of high water and of low water much more accurately than by the rude observation of the highest or the lowest water. But in discussing the low-water observations, I found an unexpected difficulty. The rise of the water at a given interval after low water (in half an hour, for instance) is *considerably* more rapid than its descent at the same interval before low water. There is in fact the rudiment of a veritable *bore*. It is impossible here to use any observations for determining the time of low water except those which are very near to the low water.

My curiosity was now excited to learn with a little more precision the laws of the rise and fall of the water generally. For this purpose, Captain SHIRREFF undertook, at my request, to arrange for the observation of the depression of the water at every quarter-of-an-hour, night and day, during half a lunation. This was done, so far as I can judge, with the most perfect regularity. The observations commenced at February 16, $12^h\ 15^m$, astronomical time, and finished at March 4, $12^h\ 0^m$. The whole number of observations is 1536.

In the computation of these observations it is to be considered that the times of high and low water are subject to perpetual irregularities, as well from the change of conformation of the sun and moon, as from the effects of the wind: and also that the heights are more conspicuously variable from the same cause. But there is this difference between them, as regards the mode of treating the observations on the present occasion. The times of high water at London are predicted with considerable accuracy in the Nautical Almanac: and though the time of high water at Deptford, even when undisturbed, is not the same as at London, yet its difference may be supposed to be nearly constant, and therefore the time of high water at London will be a proper zero of phase to which to refer the Deptford tides. But there is no prediction whatever of the depressions of the Deptford high and low waters; and therefore it appears impracticable to take any zero except the observed least and greatest depressions. These considerations suggested the following methods of reducing the observations:—

The time, between one predicted high water for London and the next, was supposed to correspond to 360° of *phase*; and the interval of each time of Deptford observation from the preceding London predicted time of high water was converted into *phase* by that proportion.

The space, between the least depression and greatest depression in one semi-tide (rise or fall), was supposed to correspond to 2, or the double radius; and the depression of the water at each Deptford observation below the least depression of that semi-tide was converted into parts of 1 or radius by that proportion.

I may remark that the results from the various tides would have agreed more exactly if an observed time of Deptford high water had been used (in the conversion of time into phase) instead of predicted time of London high water: but the process would have been more troublesome, and the advantage very small.

As there was evidently a variation in the law depending on the range of the tide, the observations were next divided into two nearly equal groups; one (of fifteen complete tides) comprising those in which the range was small; the other (of sixteen tides) comprising those in which the range was large. The former is called division A, and the latter division B. These two divisions were treated separately; although the methods of treating them are in every respect the same.

The next step was (in each division) to pick out all the phases included between 0° and 10°, and their corresponding converted depressions; and to take the mean of each of these series of numbers: then to pick out all the phases included between 10° and 20°, and their corresponding converted depressions; and to take the mean of each of these series of numbers: and so on. In this manner there were obtained, in each division, two columns of numbers (every one of which was the mean of about twenty-two numbers); one of them being a series of phases very near to 5°, 15°, &c., and the other being the corresponding converted depression. As there was no difficulty in inferring from these numbers, with considerable accuracy, the change of converted depression corresponding to a very small change of phase, it was easy to apply the correction required to adapt the converted depressions to the exact values of phase 5°, 15°, 25°, &c. In this manner the two following Tables were formed.

Division A.

Mean depression of high water 5 ft. 11 in.
Mean range of tide 15 ft. 3 in.

Phase.	Converted depression.	Phase.	Converted depression.
°		°	
5	0·068	185	1·980
15	0·167	195	1·955
25	0·318	205	1·845
35	0·476	215	1·731
45	0·626	225	1·581
55	0·783	235	1·413
65	0·921	245	1·266
75	1·062	255	1·075
85	1·183	265	0·921
95	1·299	275	0·760
105	1·438	285	0·612
115	1·525	295	0·468
125	1·645	305	0·347
135	1·725	315	0·236
145	1·810	325	0·135
155	1·885	335	0·057
165	1·934	345	0·021
175	1·965	355	0·016

Division B.

Mean depression of high water 3 ft. 6 in.
Mean range of tide 19 ft. 2 in.

Phase.	Converted depression.	Phase.	Converted depression.
°		°	
5	0·030	185	1·912
15	0·118	195	1·960
25	0·249	205	1·981
35	0·406	215	1·923
45	0·563	225	1·753
55	0·697	235	1·568
65	0·830	245	1·366
75	0·942	255	1·156
85	1·057	265	0·988
95	1·171	275	0·830
105	1·272	285	0·683
115	1·371	295	0·557
125	1·469	305	0·454
135	1·558	315	0·347
145	1·645	325	0·232
155	1·725	335	0·116
165	1·794	345	0·042
175	1·851	355	0·008

If we express the numbers in these two columns by series of sines and cosines of multiple arcs, we find the following expressions:—

Division A (neap tides).

$$\begin{aligned}\text{Converted depression} &= 1{\cdot}035\\ &\quad + 0{\cdot}198 \text{ sine phase} - 0{\cdot}918 \text{ cos phase}\\ &\quad + 0{\cdot}064 \text{ sine 2 phase} - 0{\cdot}016 \text{ cos 2 phase}\\ &\quad - 0{\cdot}010 \text{ sine 3 phase} - 0{\cdot}047 \text{ cos 3 phase}\\ &\quad + 0{\cdot}008 \text{ sine 4 phase} - 0{\cdot}009 \text{ cos 4 phase}\\ &= 1{\cdot}035 - 0{\cdot}939 \cos(\text{phase} + 12^\circ\,10') + 0{\cdot}066 \sin(2\,\text{phase} - 14^\circ\,2')\\ &\quad - 0{\cdot}048 \cos(3\,\text{phase} - 12^\circ\,1') + 0{\cdot}012 \sin(4\,\text{phase} - 48^\circ\,22').\end{aligned}$$

If we make *phase* $+ 12^\circ\,10' = p + 90^\circ$, and if we remark that, to obtain the actual depression in feet and inches below the top of the wharf-wall, we must multiply the converted depression by half the range, and must add to the product the depression of high water, we find for the actual depression,

$$5\text{ ft. }11\text{ in.} + \frac{15\text{ ft. }3\text{ in.}}{2} \times \left\{ \begin{array}{l} 1{\cdot}035 + 0{\cdot}939 \cdot \sin(p) - 0{\cdot}066 \cdot \sin(2p - 38^\circ\,22') \\ \quad - 0{\cdot}048 \sin(3p - 48^\circ\,40') + 0{\cdot}012 \sin(4p - 97^\circ\,2') \end{array} \right\},$$

or

$$13\text{ ft. }10\text{ in.} + 7\text{ ft. }7{\cdot}5\text{ in.} \times \left\{ \begin{array}{l} 0{\cdot}939 \sin(p) - 0{\cdot}066 \sin(2p - 38^\circ\,22') \\ \quad - 0{\cdot}048 \sin(3p - 48^\circ\,40') + 0{\cdot}012 \sin(4p - 97^\circ\,2') \end{array} \right\},$$

where p represents an angle increasing uniformly with the time and going through a change of 360° in one complete tide.

Division B (spring tides).

$$\begin{aligned}\text{Converted depression} &= 1{\cdot}017\\ &\quad + 0{\cdot}057 \text{ sine phase} - 0{\cdot}900 \text{ cosine phase}\\ &\quad + 0{\cdot}104 \text{ sine 2 phase} - 0{\cdot}022 \text{ cosine 2 phase}\\ &\quad - 0{\cdot}054 \text{ sine 3 phase} - 0{\cdot}043 \text{ cosine 3 phase}\\ &\quad + 0{\cdot}016 \text{ sine 4 phase} - 0{\cdot}029 \text{ cosine 4 phase}\\ &= 1{\cdot}017 - 0{\cdot}902 \text{ cosine}(\text{phase} + 3^\circ\,37') + 0{\cdot}106 \text{ sine}(2\,\text{phase} - 11^\circ\,57')\\ &\quad - 0{\cdot}069 \cdot \text{cosine}(3\,\text{phase} - 51^\circ\,28') + 0{\cdot}033 \text{ sine}(4\,\text{phase} - 61^\circ\,7').\end{aligned}$$

If we make *phase* $+ 3^\circ\,37' = p + 90^\circ$, we find as before for the actual depression of the water below the top of the wharf-wall,

$$3\text{ ft. }6\text{ in.} + \frac{19\text{ ft. }2\text{ in.}}{2} \times \left\{ \begin{array}{l} 1{\cdot}017 + 0{\cdot}902 \cdot \sin(p) - 0{\cdot}106 \sin(2p - 19^\circ\,11') \\ \quad - 0{\cdot}069 \sin(3p - 62^\circ\,19') + 0{\cdot}033 \sin(4p - 75^\circ\,35') \end{array} \right\},$$

or

$$13\text{ ft. }3\text{ in.} + 9\text{ ft. }7\text{ in.} \times \left\{ \begin{array}{l} 0{\cdot}902 \cdot \sin(p) - 0{\cdot}106 \sin(2p - 19^\circ\,11') \\ \quad - 0{\cdot}069 \sin(3p - 62^\circ\,19') + 0{\cdot}033 \sin(4p - 75^\circ\,35') \end{array} \right\},$$

where (as before) p represents an angle increasing uniformly with the time, and going through a change of 360° in one complete tide.

On these expressions we may make the following remarks:—

1st. The mean height of water (understanding by the mean height that part of the expression for the height which is independent of sines and cosines of periodical terms) is, at Deptford, not the same for spring tides and for neap tides. The mean height in the average of the high tides is 13 ft. 3 in. below the top of the wharf-wall, and in the average of the low tides is 13 ft. 10 in. below the same point; or the mean height in high tides is greater than the mean height in low tides by seven inches. The corresponding difference in the whole range of the tide is about four feet.

2nd. The curves representing the law of rise and fall of the water are different for high tides and for low tides, and both are sensibly different from the line of sines. This is evident from the algebraical expression, which contains other terms than those depending on the sine and cosine of the simple phase: but it will be more evident to the eye on the comparison of the curves as graphically traced. In Plate I. the strong line represents the law of depression of the surface of the water through every instant of a tide, the horizontal abscissa representing the time or rather the phase, and the vertical ordinate measured downwards representing the depression (as taken from the Table, page 4) for division A (neap tides): the faint line is a line of sines, whose highest point coincides with the highest point of the tide-curve (supposed to have the converted depression 0·013 for phase 350°), and whose lowest point is depressed as far as the lowest point of the tide-curve (supposed to have the converted depression 1·982). In Plate II. the curves are similarly traced for division B; the highest point of the tide-curve is supposed to have the converted depression 0·008 for phase 355°, and the lowest point is supposed to have the converted depression 1·982.

3rd. If we investigate the motion of a very long wave (as a tide-wave) in a rectangular canal whose section is everywhere the same, on the supposition that the extent of vertical oscillation bears a sensible proportion to the mean depth of the water: putting k for the mean depth, $v^2 = g\,k$, and X for the horizontal displacement of any particle (x being its original horizontal ordinate), we find the following partial differential equation:—

$$\frac{d^2\mathrm{X}}{dt^2} = \frac{v^2 \cdot \frac{d^2\mathrm{X}}{dx^2}}{\left(1 + \frac{d\mathrm{X}}{dx}\right)^3}.$$

This equation cannot (it appears) be solved in finite terms, but it may be solved approximately by successive substitution. Putting it in the shape

$$\frac{d^2\mathrm{X}}{dt^2} - v^2\frac{d^2\mathrm{X}}{dx^2} = v^2\frac{d^2\mathrm{X}}{dx^2} \times \left\{-3\frac{d\mathrm{X}}{dx} + 6\left(\frac{d\mathrm{X}}{dx}\right)^2 - \&c.\right\}$$

and first neglecting the second side of the equation entirely, and solving without it; then substituting the solution (adopting that form of function which is adapted to the sea-tide at the mouth of the canal) in the first term on the second side, and solving again; then substituting the solution in the two first terms on the second side and solving again, &c., we find as many terms as we please for X. Then the vertical

elevation V of the surface, corresponding to the particle whose original horizontal ordinate was x, is found by the equation $V = \frac{k}{1 + \frac{dX}{dx}}$. In order to find the elevation not of a given *particle* but at a given *place*, we must approximately express x, the original ordinate of the particle, in terms of x', the ordinate of the place. After all these operations, putting m for the constant which makes $m v t$ to change through 360° in one complete tide, and putting $k b$ for the coefficient of the first variable term, we find for the elevation of the water,

$$V = k\Big\{1 - b \sin(m v t - m x') + \frac{33}{32} b^3 . m x' . \cos(m v t - m x')$$
$$+ \frac{9}{32} b^3 . m^2 x'^2 . \sin(m v t - m x') + \frac{3}{4} b^2 . m x' . \sin(2 m v t - 2 m x')$$
$$- \frac{21}{32} b^3 . m x' . \cos(3 m v t - 3 m x') - \frac{27}{32} b^3 . m^2 x'^2 . \sin(3 m v t - 3 m x')\Big\},$$

where the approximation is carried to the third power of b. This expression supposes the canal unlimited at the end furthest from the sea. If the canal is stopped by a barrier, the expression changes its form. Putting a for the distance of the barrier from the sea, the elevation at the point x' is represented by

$$V = k\Big\{1 - \frac{c . \cos(m a - m x')}{\cos m a} \sin m v t + \frac{c^2}{8 \cos^2 m a}\big(\cos(2 m a - 2 m x') - \cos 2 m a\big)$$
$$+ \frac{3 . c^3 . m x' . \sin(2 m a - 2 m x')}{8 \cos^3 m a} \cos 2 m v t\Big\},$$

or, putting $k b$ for the coefficient of the first variable term, and omitting that term which does not vary with the time,

$$V = k\Big\{1 - b \sin m v t + \frac{3}{4} b^2 . m x' . \tan(m a - m x') . \cos 2 m v t\Big\},$$

where the approximation is carried to the second power of b. Neither of the supposed circumstances corresponds exactly to the case of a tidal river; but it may with some reason be supposed to be represented by something intermediate to them; the bridges and other impediments in the upper part producing in some degree the same effect as a barrier. The slope of the sides of the channel alters the magnitude of the coefficients, but does not appear to alter the general form of the expressions: the investigation, however, though not difficult, is so troublesome that I have not completed it. Thus from theory we should expect the variable part of the converted depression to be expressed by a formula intermediate to the two following, the multiplier $k b$ being omitted:

$$+ \sin(m v t - m x') - \frac{3}{4} b . m x' . \sin(2 m v t \quad 2 m x'),$$

$$+ \sin m v t - \frac{3}{4} b . m x' . \tan(m a - m x') . \cos 2 m v t.$$

To see clearly the import of this, suppose that our intermediate formula is to be half the sum of these two expressions. Its form then becomes

$$+\cos\frac{mx'}{2}\cdot\sin\left(mvt-\frac{mx'}{2}\right)$$

$$-\frac{3}{8}b.mx'\left\{\cos 2mx'.\sin 2mvt-\left(\sin 2mx'-\tan(ma-mx')\right)\cos 2mvt\right\}.$$

Let

$$\frac{\sin 2mx'-\tan(ma-mx')}{\cos 2mx'}=\tan(2mx'-D),$$

then the expression may be put in the form

$$+B\sin\left(mvt-\frac{mx'}{2}\right)-C\sin(2mvt-2mx'+D),$$

or, if $mvt-\frac{mx'}{2}=p$, the theoretical converted depression is

$$+B\sin p-C\sin(2p-mx'+D).$$

When $ma-mx'$ is not large (as it certainly cannot be at Deptford), mx' is greater than D, and the theoretical converted depression, putting A for $mx'-D$, is

$$+B.\sin p-C.\sin(2p-A).$$

This is precisely the same form as that given by the discussion of the observations.

4th. According to the theory, the coefficient of the second variable term in the expression for the converted depression ought to be proportional to the range of the tide (for it contains b as a factor). In the discussion of the observations it appears that this coefficient increases more rapidly than b. This seems to render it probable that terms of sensible magnitude would be introduced by pushing the approximation to the fourth and higher orders.

5th. Suppose then that the variable part of the converted depression is represented by $\sin\theta-c\sin(2\theta-A)$, where θ, as appears from the theory, is $mvt-mx'$, or is the value of the phase depending simply on the depth of the canal and the distance of the point of observation from the sea, or is that value of phase which would correspond to a shallow wave passing along the canal. The values of θ for high and low water will be those which satisfy the equation $\cos\theta-2c.\cos(2\theta-A)=0$. Solving this equation for high water, by successive substitution, we have as a first approximation $\cos\theta=0$, or $\theta=270°$; $\cos(2\theta-A)=\cos(540°-A)=-\cos A$; using this substitution in the second term, the equation becomes $\cos\theta+2c\cos A=0$; or if $\theta=270°+x$, $\sin x+2c\cos A=0$, or $x=-2c.\cos A$ nearly, and therefore the value of $mvt-mx'$ for high water is $270°-2c\cos A$ nearly. In the same way it is found that the value of $mvt-mx'$ for low water is $90°+2c\cos A$ nearly. So far, therefore, as depends on this term, the high water is accelerated and the low water is retarded by nearly equal terms: and this acceleration and retardation are proportional to c, or to b, or to the whole range of the tide: and are therefore greater for spring tides than for neap tides.

6th. This remark enables us to explain a circumstance which appeared somewhat perplexing. It has been found by Sir J. W. Lubbock and Mr. Whewell that the age of the tide is different, as inferred from the *height* of the high water, or from the *time* of high water: the age of the tide always appearing greater as inferred from the *heights**. Now to explain this, we have to consider that, at syzygies of the sun and moon, the time of high water in the sea is on every successive day earlier with respect to the moon's transit; but the syzygial or spring tide in the river, and the tides near it, are (as we have just found) accelerated with respect to the sea-tide more than mean tides are: and therefore the river tide which happens at the mean interval from the moon's transit is not the syzygial tide, but a tide preceding it. But there is no corresponding effect produced on the height of the tide. Thus the age of the tide inferred from the height is the true age (at least as far as it can be ascertained from the phenomena of the ocean-tides); the age as inferred from the time of high water is certainly too small, and the quantity by which it is too small depends on the length and depth of the river, or of the shallows along which the tide has to pass.

I have only to add the following deductions from the observations.

In division A (low tides) the high water occurred at the phase 350° nearly, that is, about 20^m before the predicted time of high water at London Bridge: the low water occurred at the phase 185° nearly: the interval between high water and low water was about 195° of phase, and that between low water and high water about 165° of phase; or the descent occupied a longer time than the ascent by 30° of phase, or a little more than an hour of time.

In division B (high tides) the high water occurred at the phase 355° nearly, or about 10^m before the predicted time of high water at London Bridge: the low water occurred at the phase 205° nearly; the descent therefore occupied 210° of phase, and the ascent 150°; or the time of descent exceeded that of ascent by 60° of phase, or $2^h\ 4^m$ of time.

The times of the turn of the tide-current, as shown by the swinging of the ships at anchor in the river, were regularly observed. The means of the corresponding phases in division A are 10°·4 and 204°·4, or nearly 20° of phase or 40^m of time after high and low water respectively: those in division B are 14°·0 and 223°·5, or nearly 18°·5 of phase or 37^m of time after high and low water respectively.

* Lubbock, Philosophical Transactions, 1837. Whewell, Philosophical Transactions, 1838.

Royal Observatory, Greenwich,
June 25, 1841.

II. *Contributions to Terrestrial Magnetism.—No. III.*

By Lieut.-Colonel Edward Sabine, *R.A., F.R.S.*

Received December 16, 1841,—Read January 20, 1842.

In the present number of these Contributions, I propose to give an account of the observations on the magnetic intensity made at sea by the officers of Her Majesty's ships Erebus and Terror, on their passage from England to Kerguelen Island, the unreduced observations, transmitted to the Admiralty by the Commanders, Captains Ross and Crozier, having been placed in my hands for that purpose.

They will be divided for convenience into two sections, viz.

§ 5. *Observations between England and the Cape of Good Hope.* § 6. *Observations between the Cape of Good Hope and Kerguelen Island.*

§ 5. *Observations between England and the Cape of Good Hope.*

The observations in the Erebus were made by the statical method devised by Mr. Fox, with one of his instruments of 7½ inches diameter. The intensities were measured by the angles of deflection produced, in different localities, by a constant weight applied to a grooved wheel on the axle of the needle; and the ratio of the intensities is inversely as the sines of the angles of deflection, subject to a correction for differences of temperature of the needle, computed by the formula ·00016 I′ $(t'-t)$, in which t is the standard and t' the observed temperature in degrees of Fahrenheit, ·00016 a coefficient determined experimentally by Mr. Fox, and I′ the observed intensity. At sea, where the manipulation of the weights causes an exposure of the needle, which, in bad weather particularly, is liable to occasion injury, the plan recommended by Mr. Fox, of using deflecting magnets instead of weights, was frequently resorted to. In this case the ratio of the intensity in different localities is inversely as the sines of the angles of deflection, and directly as the weights equivalent to the deflecting force of the deflector on the needle at the respective angles; or

$$I' = I \cdot \frac{w'}{w} \cdot \frac{\sin v}{\sin v'},$$

where I, v, and w are the intensity, angle of deflection, and equivalent weight at a base station; and I′, v', and w' corresponding values at another station. A table is usually formed for each instrument experimentally, under Mr. Fox's own direction, of the equivalent, or as they are termed by him, the *coercing* weights, for each deflector on each of the needles at the different angles which are likely to occur in the course of the observations. This is done by placing the deflector successively at

angles from the dip*, each differing one degree from the preceding; the needle is thereby deflected to a smaller angle on the side of the dip opposite to the deflector, and is brought back to the dip by a weight applied to the grooved wheel on the axle; this weight is called the coercing weight corresponding to the angle from the dip at which the deflector was placed. For greater accuracy, the table is formed from results obtained by placing the deflector successively on either side of the needle. Owing to accidental circumstances, no table of this description was prepared for this instrument before the Expedition sailed; the pressure of other duties prevented its being done at St. Helena, the Cape of Good Hope, or at Kerguelen Island; and at Van Diemen Island the end of the axle of the needle being accidentally broken, the needle was returned to England to be repaired, and was thus separated from the instrument and from the deflectors. Under these circumstances we have no other resource for reducing the observations made with the deflectors, than to form a table from the observations of the weights and deflectors (when both methods have been employed at the same station), which shall answer the same purpose as a table of coercing weights. Fortunately the number of such stations is considerable.

We may form this table in the following manner. For the primary or base station, let V be the angle of deflection with a constant weight W, and v the angle of deflection produced by the deflector placed at the dip, then is

$$w = \mathrm{W} \sin v \operatorname{cosec} \mathrm{V},$$

w being the weight equivalent to the deflecting force of the deflector at the angle v. If several constant weights were used at the primary station, the value of w may be obtained from each separately, and an arithmetical mean taken. Then at another station, at which the angles of deflection have been observed both with the deflector and with constant weights, the equivalent weight w' to the angle v' produced by the deflector may be obtained from

$$w' = \frac{\mathrm{I}' w \sin v'}{\mathrm{I} \sin v},$$

I being the intensity at the primary station, and I' the intensity derived by the method of constant weights at the other station. The values of w', thus computed for all the stations where the weights and deflectors were both used, being projected in a graphical representation with the corresponding values of v', the former as ordinates, the latter as abscissæ, a line drawn by the eye through the terminations of the ordinates will give the values of w' for each degree of v' produced by the deflector.

In the intensity instrument of the Erebus two deflectors were used, sometimes separately and sometimes combined: they were designated N. and S, according to the pole of the needle to which they were respectively applied. They were contained in brass tubes, N. with its north pole, and S. with its south pole towards the end of the tube which screwed into the limb of the instrument; consequently "Deflector N." in

* This analysis may be made when the needle is in other positions, but Mr. Fox now prefers the *vertical* one, or when the needle stands at 90°, the circle being perpendicular to the plane of the magnetic meridian.

the Table signifies that the deflector having its north pole towards the screw was placed opposite that division of the circle which the north end of the needle had previously indicated as the dip; and the angle of deflection v' is a mean of the deflections of the needle, first on the one side and then on the other side of the deflector.

In the case of this deflector we have the angle v observed in London 22° 57′; and the value of w, derived from the angles with the four constant weights of 1, 2, 3, and 4 grains, = 2·114 grs. Regarding London as the primary station, and the intensity = 1, the values of w' at the several stations where both weights and deflectors were used are found by

$$w' = 5{\cdot}422\ \mathrm{I}'\sin v'.$$

The table of observations furnishes seventy-four occasions between England and the Cape of Good Hope, in which this deflector was used in comparison with the constant weights: we have consequently so many values of w' from which to form a table for each degree of deflection. The angles v' produced by this deflector increased from 22° 57′ in London to above 34° where the intensity was weakest, and again decreased to 29° 53′ at the Cape; consequently the ordinates corresponding to the smaller angles are derived partly from the earlier and partly from the later observations of the series. The line drawn freely through the points forming the terminations of the ordinates shows by its continuity that the force of the deflector remained unchanged during the whole of the series; it exhibits no discordances with any of the values of w', but such as may well be attributed to the unavoidable discrepancies of single observations. By means of this graphical representation the subjoined Table has been formed of the values of w' for each degree of v', permitting the intensities I′ to be computed, relative to the force unity in London, by the formula

$$\mathrm{I}' = {\cdot}1845\ w' \operatorname{cosec} v'.$$

Values of w', Deflector N.	
° grs.	° grs.
23 = 2·113	30 = 1·929
24 = 2·085	31 = 1·904
25 = 2·058	32 = 1·880
26 = 2·031	33 = 1·857
27 = 2·005	34 = 1·834
28 = 1·979	35 = 1·810
29 = 1·954	

In the case of deflector S, the table of observations furnishes 109 occasions between London and the Cape of Good Hope in which the angle v' was observed in comparison with the angles produced by the constant weights; consequently we have 109 values of w' to be combined in a graphical representation. The line freely drawn through the terminations of the ordinates is continuous from August 1839 to the noon-observation of February 12, 1840, when the continuity becomes interrupted, and a second line, corresponding to a diminished force in the deflector, commences, and continues unbroken to the Cape of Good Hope. The loss of force in the de-

flector, which occurred between the forenoon and afternoon observations of the 12th of February, was equivalent to nearly a degree in the angle v', and is obvious on a simple inspection of the table of observations. In this case, therefore, we require to form two tables of the values of w'; the one, Table A, corresponding to the force of the deflector between August 1839 and February 12th, 1840, and the other, Table B, to the weaker force between February 12th and the Cape of Good Hope.

Values of w', Deflector S.

(A.) August 1839 to February 12, 1840.		(B.) February 12 to March 25, 1840.
° grs.	° grs.	° grs.
30 = 2·754	37 = 2·410	35 = 2·291
31 = 2·704	38 = 2·359	36 = 2·260
32 = 2·655	39 = 2·310	37 = 2·235
33 = 2·606	40 = 2·260	38 = 2·210
34 = 2·556	41 = 2·210	39 = 2·186
35 = 2·508	42 = 2·160	40 = 2·161
36 = 2·459	43 = 2·110	41 = 2·135
		42 = 2·110

For the first series we have London as the primary station, where $I = 1$, $v = 30° 19'$, and $w = 2·737$; whence

$$I' = ·1845\ w' \operatorname{cosec} v'.$$

the values of w' being taken from Table A. And for the second series we have the Cape as the primary station, where $v = 35° 40'$, $w = 2·270$, and I, derived from the experiments with the constant weights = 0·715 (London = 1); consequently at other stations

$$I' = ·1837\ w' \operatorname{cosec} v'.$$

the values of w' being taken from Table B.

The loss of force sustained by deflector S. causes a similar interruption in the continuity of the line connecting the terminations of the ordinates derived from the observations in which the deflectors N. and S. were used conjointly; we have therefore in this case also two tables of the values of w', one for the first, and the other for the second series.

Values of w', Deflectors N. and S.

(A.) August 1839 to February 12, 1840.		(B.) February 12 to March 25, 1840.
° grs.	° grs.	° grs.
44 = 3·784	53 = 3·118	51 = 3·037
45 = 3·674	54 = 3·056	52 = 2·989
46 = 3·584	55 = 2·995	53 = 2·943
47 = 3·505	56 = 2·936	54 = 2·896
48 = 3·430	57 = 2·880	55 = 2·853
49 = 3·366	58 = 2·828	56 = 2·813
50 = 3·304	59 = 2·780	57 = 2·775
51 = 3·242	60 = 2·738	58 = 2·740
52 = 3·180		

For the first series we have London as the primary station, where $I = 1$, $v = 44° 06'$, and $w = 3{\cdot}773$; whence at other stations

$$I' = {\cdot}1845\, w' \operatorname{cosec} v',$$

w' being taken from Table A; and for the second series the Cape as the primary station, where $I = 0{\cdot}715$, $v = 51° 10'$, and $w = 3{\cdot}032$; whence at other stations

$$I' = {\cdot}1837\, w' \operatorname{cosec} v',$$

w' being taken from Table B.

Table I. contains the observations made with the weights and deflectors on shore and on board the Erebus, between London and the Cape of Good Hope. Of 647 observations comprised in this Table, I have only found it necessary to consider a single one as doubtful, namely, the second observation with the constant weight of one grain at the Cape of Good Hope; its result differs so much from that of the observation on the preceding day with the same weight, and with those of the preceding and of the same day with the weight of $1\frac{1}{2}$ grain, that I have thought it safer to omit it in taking the mean of the results at that station; but the observation itself, and its result, are both given in the Table.

Table I.

Observations of the Magnetic Intensity on Shore, and on Board Her Majesty's Ship Erebus, with Needle F, by Captain James Clark Ross.

London to the Cape of Good Hope.

1839.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000	Intensity. = 1·372
			h m		° ′				
Aug. 28.	Westbourn Green near London.		5 P.M.	Deflector S.	30 19	70			
				Deflector N.	22 57				
				Deflectors S. & N.	44 6				
				weight 1 grain.	10 34		Observed on shore.	1·000	1·372
				weight 2 grains.	21 47				
				weight 3 grains.	33 24				
				weight 4 grains.	47 52				
Oct. 1.	50 42	0 35	1 P.M.	S.	30 38	60		·985	
			11 A.M.	weight 2 grains.	21 54		w. by N.	·993 ·990	1·358
			Noon.	weight 4 grains.	48 17			·992	
3.	50 17	357 26	10 30 A.M.	weight 2 grains.	21 41	60	w. by N.	1·003 1·001	1·373
				weight 4 grains.	47 45			1·000	
8.	47 47	350 42	10 A.M.	S.	30 43	56	s.w. by w.	·981 1·007	1·382
				weight 2 grains.	21 1			1·033	
13.	41 6	348 10	9 A.M.	S.	30 43	61	s.w. by w.	·982	
				S. and N.	45 1			·959 ·966	1·326
				weight 2 grains.	22 43			·959	
14.	39 30	347 51	9 30 A.M.	S.	30 22	65	s.w. by w.	·993	
			10 15 A.M.	S. and N.	44 35			·978 ·977	1·346
			11 0 A.M.	weight 2 grains.	22 45			·959	
21.	Funchal Roads.		10 0 A.M.	S.	31 14	73	w. by s.	·958	
				S. and N.	45 17			·948 ·949	1·302
			11 0 A.M.	weight 2 grains.	23 7	73		·946	
				weight 4 grains.	51 45			·945	
23.	Consul's House, Funchal.		7 A.M.	S.	31 18	70	Observed on shore.	·955	
			10 A.M.	S. and N.	45 17	71		·948	
			Noon.	weight 2 grains.	23 12	70		·942 ·946	1·297
	32 38	343 04	0 30 P.M.	weight 3 grains.	35 45			·942	
24.?			10 30 A.M.	weight 4 grains.	51 55			·943	
26.	Funchal Roads.		2 0 P.M.	S.	31 10	70	w. by s.	·961	
			3 10 P.M.	weight 1 grain.	11 23	74		·930 ·941	1·291
			3 50 P.M.	weight 2 grains.	23 20			·937	
			4 30 P.M.	weight 3 grains.	36 5			·935	
Nov. 1.	30 47	343 10	10 A.M.	S.	31 26	70	s.s.w.	·948	
			to	weight 1 grain.	11 29			·921 ·931	1·277
			Noon.	weight 2 grains.	23 39			·925	
4.	Off Santa Cruz, Teneriffe.		10 A.M.	S.	31 53	76	s.s.w.	·929	
			to	weight 1 grain.	11 40			·908 ·916	1·256
			Noon.	weight 2 grains.	24 5			·910	
6.	26 1	342 25	10 A.M.	S.	32 34	74	s.w. ½ w.	·900	
			10 20 A.M.	S. and N.	46 42			·894	
			11 15 A.M.	weight 2 grains.	24 37			·892	
			11 50 A.M.	weight 3 grains.	38 48			·879 ·905	1·241
			1 30 P.M.	S.	31 34	74	N.W. ½ N.	·943	
			2 0 P.M.	S. and N.	45 58			·920	
7.	24 51	341 18	10 30 A.M.	S.	32 58	77	s.w. ½ w.	·884	
				S. and N.	46 52			·889 ·886	1·216
8.	23 40	340 45	0 30 P.M.	S.	33 3	76	s.w. ½ w.	·880	
			4 0 P.M.	S.	33 8	74	s.w. ½ w.	·877	
			1 30 P.M.	S.	32 45	72	E.	·892	
			2 15 P.M.	S.	32 51	73	w.	·888 ·883	1·212
			3 0 P.M.	S.	33 4	73	s.	·879	
			3 30 P.M.	weight 1 grain.	11 54		s.w. ½ w.	·890	
			4 0 P.M.	weight 2 grains.	25 12		s.w. ½ w.	·872	

TABLE I. (Continued.)

1839.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000		= 1·372
			h m		° ′	°				
Nov. 9.	22 18	340 03	9 A.M.	S.	33 13	74		·874		
			to	N.	25 31			·874		
			11 A.M.	S. and N.	47 24			·871	·874	1·199
			2 P.M.	N.	25 29			·878		
			3 P.M.	weight 1 grain.	11 58	73		·885		
				weight 2 grains.	25 30			·862		
10.	20 54	339 18	1 P.M.	S.	33 32	74		·861		
				weight 1 grain.	12 4			·880	·867	1·190
				weight 2 grains.	25 38			·859		
11.	19 8	338 07	9 A.M.	S.	33 56	76	S.W. ½ W.	·846		
				N.	25 54			·859	·854	1·171
				S. and N.	47 49			·858		
12.	17 10	336 55	10 30 A.M.	S.	34 8	78		·839		
				N.	26 0			·855		
				S. and N.	48 4			·850	·849	1·164
			Noon. to	weight 1 grain.	12 14	78		·866		
			1 P.M.	weight 2 grains.	26 6			·845		
				weight 3 grains.	41 0			·840		
14.	Quail Island.		10 A.M.	S.	34 4	91		·841		
			to Noon.	N.	25 59			·855		
	14 54	336 30		S. and N.	48 15		Observed	·844	·844	1·157
			1 30 P.M.	weight 1 grain.	12 36	93	on shore.	·844		
				weight 2 grains.	26 0			·850		
				weight 3 grains.	41 41			·831		
18.	Porto Praya.		6 to	S.	33 57	74	N.E.	·845		
			7 30 A.M.	S.	34 34	76	E.	·822		
			8 to	S.	33 53	78	N.	·847		
			9 30 A.M.	S.	34 30	79	W.	·825	·840	1·153
			10 to	S.	34 19	80	S.	·833		
			11 30 A.M.	S.	33 13	80	N.W.	·872		
			0 45 P.M.	S.	34 21	80	S.E.	·830		
			3 0 P.M.	S.	33 57	84	S.W.	·845		
21.	12 39	335 35	9 30 to	S.	34 4	79	S.W.	·841		
			11 A.M.	N.	26 8			·849		
				S. and N.	48 51			·827	·831	1·140
				weight 1 grain.	13 2			·815		
				weight 2 grains.	26 50			·824		
22.	11 19	335 07	Noon to	S.	34 46	81	S.W.	·815		
			1 30 P.M.	N.	27 6			·811	·813	1·115
				S. and N.	49 24			·812		
23.	9 48	334 41	11 30 A.M.	S.	35 1	84	S.W.	·806		
			to	N.	27 20			·802		
			1 P.M.	S. and N.	49 50			·800	·793	1·088
			3 to	weight 1 grain.	13 45	83		·773		
			4 P.M.	weight 2 grains.	28 24			·786		
25.	6 52	333 55	10 A.M.	S.	35 59	83	S.S.W.	·772		
				N.	28 38			·756		
				S. and N.	51 6			·767	·763	1·046
				weight 1 grain.	14 3			·757		
				weight 2 grains.	29 14			·761		
26.	5 13	333 35	10 A.M.	S.	36 13	83	S.S.W.	·764		
				N.	29 1			·743	·752	1·032
				S. and N.	51 51			·748		
29.	3 20	332 48	10 A.M.	S.	37 8	82	S.W. by S.	·734		
				N.	29 23			·731	·732	1·004
				S. and N.	52 29			·732		

TABLE I. (Continued.)

1839.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.	Intensity. = 1·372
			h m		° ′	°			
Nov. 30.	2 6	331 25	10 A.M.	S.	37 17	81	S.S.W. ½ W.	·729	
				N.	30 3			·711	
				S. and N.	52 34			·730	·728 ·998
				weight 1 grain.	14 30	83		·734	
				weight 2 grains.	30 24			·735	
Dec. 2.	St. Paul's Rocks.		8 A.M.	S.	37 8	90		·734	
	0 56	330 40	to	N.	29 34		Observed on shore.	·725	
			9 30 A.M.	S. and N.	52 44			·726	·727 ·997
			3 P.M.	weight 1 grain.	14 39			·727	
				weight 2 grains.	30 50			·726	
3.	0 24	330 19	10 A.M.	S.	37 41	84	S.S.W. ½ W.	·717	
			to	N.	30 11			·706	·712 ·977
			11 30 A.M.	S. and N.	53 15			·714	
4.	— 0 28	330 02	11 A.M.	S.	37 46	82	S. by W. ½ W.	·716	
			to	N.	30 29			·697	·700 ·960
			Noon.	S. and N.	53 49			·694	
5.	— 1 37	329 17	10 30 A.M.	S.	38 10	83	S.S.W.	·702	
			to	N.	30 29			·697	
			Noon.	S. and N.	54 2			·696	·699 ·959
				weight 1 grain.	15 27			·690	
			1 P.M.	weight 2 grains.	32 6			·710	
6.	— 3 18	328 31	10 A.M.	S.	38 47		S.S.W.	·683	
			10 40 A.M.	S. and N.	54 48			·679	·683 ·937
			11 30 A.M.	N.	30 51			·686	
7.	— 4 49	327 43	9 30 A.M.	S.	39 7	81	S.S.W.	·674	
				S. and N.	55 1			·674	
				N.	31 24			·671	
				weight 1 grain.	16 16	82		·656	·672 ·921
				weight 2 grains.	32 26			·693	
				weight 3 grains.	56 7			·664	
8.	— 6 24	327 24	11 30 A.M.	S.	39 35	82	S.	·659	·654 ·897
			Noon.	weight 1 grain.	16 25			·650	
9.	— 7 50	327 28	9 30 A.M.	S.	39 50	80	S.	·652	
			10 10 A.M.	S. and N.	55 50			·657	
			10 45 A.M.	N.	32 47			·635	·648 ·888
			11 30 A.M.	weight 1 grain.	16 37	80		·642	
			Noon.	weight 2 grains.	34 42			·653	
10.	— 9 21	327 58		S.	40 13	81	S.S.E.	·642	
				S. and N.	57 2			·633	
				N.	33 7			·626	·635 ·870
				weight 1 grain.	16 41	83		·640	
				weight 2 grains.	35 53			·635	
11.	—11 3	328 22		S.	41 0	81	S.S.E.	·622	
				S. and N.	57 18			·628	
				N.	33 29			·617	·624 ·856
				weight 1 grain.	17 7	81		·624	
				weight 2 grains	36 8			·631	
12	—12 32	328 57	10 A.M.	S.	41 24	82	S.E. by S.	·611	
			10 55 A.M.	S. and N.	57 23			·626	
			11 45 A.M.	N.	33 40			·613	·611 ·840
			1 P.M.	weight 1 grain.	17 56	82	S.S.E. ½ E.	·597	
			2 P.M.	weight 2 grains.	36 56			·619	
13.	—14 00	329 28	0 30 P.M.	weight 1 grain.	18 0	82	S.S.E.	·594	
			1 P.M.	weight 2 grains.	37 57			·605	
			1 15 P.M.	S.	41 51	82		·599	·599 ·822
			2 0 P.M.	S.	41 42			·603	
			6 P.M.	weight 1 grain.	18 1	79		·594	

TABLE I. (Continued.)

1839.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.	Intensity. = 1·372
Dec. 14.	−15° 4′	330° 06′	10 A.M.	S.	41° 58′	80°	S.S.E.	·596	
				S. and N.	58 17			·610	
				N.	34 13			·600	·599 ·822
				weight 1 grain.	18 7	81		·591	
				weight 2 grains.	38 27			·598	
15.	16 52	330 27	9 30 A.M.	S.	42 3	79	S. by E.	·594	
			10 20 A.M.	S. and N.	58 40			·602	
			10 50 A.M.	N.	34 21			·597	·596 ·818
			11 10 A.M.	weight 1 grain.	18 10	79		·589	
			Noon.	weight 2 grains.	38 30			·597	
16.	−19 1	330 45	10 A.M	S.	42 12	78	S. ½ E.	·591	
			to	N.	34 23	78		·596	
			Noon.	S. and N.	59 1	78		·598	
			0 15 P.M.	weight 1 grain.	18 7	78		·591	·593 ·814
			to	weight 1 grain.	18 14	78		·587	
			2 30 P.M.	weight 2 grains.	38 47	78		·593	
				weight 2 grains.	38 48	78		·593	
17.	Island of Trini-		10 A.M.	S.	42 5	80		·593	
	dad.			N.	34 34	80	Observed	·592	
	−20 31	330 38	to	S. and N.	59 1	80	on shore.	·598	·592 ·813
				weight 1 grain.	18 14	80		·587	
			Noon.	weight 2 grains.	38 42	80		·595	
18.	−21 31	330 47	10 A.M.	S.	42 3	78	S.	·594	
			to	N.	34 5			·603	
			Noon.	S. and N.	59 4			·597	
				weight 1 grain.	18 6	79		·591	·596 ·818
				weight 1 grain.	18 9			·590	
				weight 2 grains.	38 28			·598	
				weight 2 grains.	38 27			·598	
	−21 47	330 50	5 30 P.M.	S.	42 8	76	S.	·592	
			to	N.	34 13			·600	·597 ·819
			7 P.M.	S. and N.	58 55			·598	
19.	−23 8	330 49	9 A.M.	S.	41 52	79	S. ½ W.	·599	
				weight 1 grain.	17 56			·597	·600 ·823
				weight 2 grains.	37 37			·609	
	−23 20	331 0	6 P.M.	S.	41 58	76	S.E.	·596	
20.	−24 16	331 45	9 30 A.M	S.	41 16	77	S.E. by S.	·615	
				N.	34 8	77		·602	
			to	S. and N.	59 5	77		·597	·604 ·829
			Noon.	weight 1 grain.	17 52	78		·599	
				weight 2 grains.	37 34	78		·610	
	−24 28	331 57	6 P.M.	S.	41 48	76		·601	
				N.	34 4		S.S.E.	·603	·603 ·828
				S. and N.	58 33			·606	
21.	−25 38	332 41	10 A.M.	S.	41 56	76		·599	
			to	N.	34 16	76		·599	
			Noon.	S. and N.	58 46	76	S.E. by E. ½ E.	·603	
			0 40 P.M.	weight 1 grain.	17 50	78		·600	·603 ·828
			1 30 P.M.	weight 2 grains.	37 16	78		·614	
	−25 42	332 51	5 P.M.	S.	41 50	77		·600	
				N.	33 53		S.E.	·608	
				S. and N.	58 53			·602	
22.	−26 52	333 30	11 A.M.	S.	41 10	77	S.S.E.	·617	
			to	N.	33 43			·611	
			2 P.M.	S. and N.	58 9			·613	
				weight 1 grain.	17 44	78		·603	·612 ·839
				weight 1 grain.	17 44		S.S.E.	·603	
				weight 2 grains.	36 56			·618	
				weight 2 grains.	36 56		S.S.E.	·618	

TABLE I. (Continued.)

1839.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.	Intensity. = 1·372.
			h m		° ′	°			
Dec. 22.	−26 49	333 30	2 to 3 P.M.	S.	41 30	77	N. by E.	·608	
				N.	33 23			·620	
				S. and N.	58 16			·611	·840
				weight 1 grain.	17 42	77		·604	
				weight 2 grains.	36 48			·620	
23.	−26 12	333 20	9 A.M.	N.	33 17	78	N. ½ W.	·622	
			10 A.M.	N.	33 57	78	S.E.	·606	
			11 A.M.	S.	41 46	78		·602	
	−26 12	333 23	Noon.	S. and N.	58 55	78		·599	·833
			0 30 P.M.	weight 1 grain.	17 45	77		·602	
			1 P.M.	weight 2 grains.	37 18			·613	
24.	−27 4	334 10	10 A.M.	S.	41 35	76	E.	·605	
			1 P.M. to	S.	41 31	77	S.E. by E.	·608	
				N.	34 0	77		·605	
	−27 4	334 16	3 30 P.M.	S. and N.	58 37			·605	·836
				weight 1 grain.	17 40	76		·605	
				weight 2 grains.	36 56			·618	
				weight 2 grains.	36 41			·622	
25.	−27 46	335 04	10 30 A.M.	S.	41 13	76	S. by E.	·615	
			to	N.	33 23	76		·620	
			11 30 A.M.	S. and N.	58 1	76		·615	
			Noon	S.	41 22	76		·611	·845
			to 2 P.M.	N.	33 47			·610	·617
				S. and N.	58 11		N.N.E. ½ E.	·612	
	−27 41	335 08	2 30 to	weight 1 grain.	17 22	76		·615	
			3 30 P.M.	weight 2 grains.	35 47			·635	
26.	−26 53	335 26	9 to	S.	41 23	76	N.N.E.	·611	
				N.	33 47		N.	·610	
			11 20 A.M.	S. and N.	57 46			·619	·840
			11 30 to	weight 1 grain.	17 40	78	S.S.E.	·605	·613
			0 30 P.M.	weight 2 grains.	37 0			·618	
27.	−26 6	335 19	10 A.M. to	S.	41 41	77	N. by E.	·603	
				N.	33 55	77		·607	
			Noon.	S. and N.	58 8	77		·613	·833
	−25 57	335 20	3 30 P.M.	weight 2 grains.	37 46	76	N.E. by N.	·607	·607
			4 10 P.M.	weight 1 grain.	17 51	76		·599	
28.	−25 21	335 28	10 A.M.	S.	41 55	78	S.E. by E.	·599	
			to	N.	34 3	78		·604	
			Noon.	S. and N.	58 32	78		·607	
			0 45 P.M.	weight 1 grain.	17 51	79	S.E.	·599	·826
			1 30 P.M.	weight 2 grains.	38 12	79		·601	·602
			6 30 P.M.	weight 1 grain.	17 53	76	S.E. by S.	·598	
			7 P.M.	weight 2 grains.	38 2	76		·603	
29.	−26 12	336 12	11 A.M.	S.	41 37	79		·604	
			to	N.	34 0	79		·605	
			1 P.M.	S. and N.	58 44	79		·603	
			to	weight 2 grains.	37 46	79	S.E. by E.	·601	·604
				weight 2 grains.	37 45	79		·601	
			3 P.M.	weight 1 grain.	17 46	79		·607	
				weight 1 grain.	17 49	79		·606	
30.	−27 4	337 22	10 A.M.	S.	41 24	79		·611	
			to	N.	33 56	79		·606	
			Noon.	S. and N.	58 50			·602	
	−27 5	337 28	0 15	weight 1 grain.	17 55	77	S.E.	·597	·832
			to	weight 1 grain.	17 50			·600	·606
				weight 2 grains.	37 16	77		·614	
			1 40 P.M.	weight 2 grains.	37 18			·613	

TABLE I. (Continued.)

1839.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.	Intensity. = 1·372.
			h m		° ′				
Dec. 31.	−27 45	338 34	10 A.M.	S.	41 27	78	S.E. by E. ½ E.	·610	
			to	N.	34 12	78		·600	
			Noon.	S. and N.	58 50	78		·602 ·607	·833
	−27 44	338 40	2 P.M.	weight 2 grains.	36 47	76	E.S.E.	·620	
			3 P.M.	weight 1 grain.	17 48	76		·601	
1840.									
Jan. 1.			10 30 A.M.	S.	41 39	77		·604	
			11 A.M.	N.	34 5			·603	
			11 30 A.M.	S. and N.	58 56		E. by S.	·599 ·603	·828
	−28 19	340 10	Noon.	weight 1 grain.	17 52			·598	
			0 30 P.M.	weight 2 grains.	37 20			·612	
2.	−28 5	341 39	9 30 P.M.	S.	41 49	76		·600	
			10 00 P.M.	N.	33 59			·605	
			10 30 P.M.	S. and N.	59 0			·598	
			11 0 P.M.	weight 1 grain.	17 56	76	E.N.E.	·596 ·603	·828
	−27 57	341 50	Noon.	weight 1½ grain.	27 7			·605	
			1 P.M.	weight 2 grains.	37 36			·609	
3.	−27 26	342 29	9 30 A.M.	S.	41 31			·607	
			10 0 A.M.	N.	33 58		N.E. by E.	·606 ·605	·830
			10 40 A.M.	S. and N.	58 45			·603	
4.	−26 51	342 56	9 30 A.M.	S.	41 32			·607	
			10 0 A.M.	N.	34 5			·603	
			10 30 A.M.	S. and N.	58 59		N.E. by N.	·598 ·601	·824
			11 30 A.M.	weight 1 grain.	18 2			·593	
	−26 42	343 0	Noon.	weight 2 grains.	38 7			·602	
5.			11 A.M.	S.	41 37		N.N.E.	·605	
			11 30 A.M.	N.	34 23		N. by E. ½ E.	·596	
	−25 39	342 57	Noon.	S. and N.	59 1			·598 ·600	·823
			1 P.M.	weight 1 grain.	18 7	76		·590	
			2 P.M.	weight 1½ grain.	26 40		N.N.E.	·615	
	−25 29	342 58	3 P.M.	weight 2 grains.	38 20			·599	
6.			11 30 A.M.	S.	41 52	76	N.N.E.	·599	
	−24 13	343 3	Noon.	N.	34 23			·596	
			0 30 P.M.	S. and N.	59 13			·595 ·592	·812
			1 0 P.M.	weight 1 grain.	18 9	76	N.E. by N.	·589	
	−24 6	343 06	3 0 P.M.	weight 1 grain.	18 14			·587	
			5 30 P.M.	weight 1 grain.	18 12			·588	
7.			10½ A.M.	S.	42 2	74		·595	
			11 15 A.M.	N.	34 34	74		·592	
	−22 49	343 35	Noon.	S. and N.	59 23			·593	
			2 30 P.M.	weight 1 grain.	18 7	74	N.E.	·590 ·591	·811
			5 30 P.M.	weight 1 grain.	18 20	74	N.E. ½ E.	·584	
	−22 39	343 43	6 0 P.M.	S.	42 3	73		·595	
			6 30 P.M.	N.	34 30			·593	
	−22 34	343 49	7 0 P.M.	S. and N.	59 33			·590	
8.			10½ A.M.	S.	42 10	76	N.E. by E.	·592	
			11 15 A.M.	N.	34 34			·592	
	−21 34	344 15	Noon.	S. and N.	59 39			·589 ·590	·810
			2 30 P.M.	weight 1 grain.	18 6	75		·591	
	−21 27	344 19	3 0 P.M.	weight 1 grain.	18 26			·580	
9.	−20 31	345 05	10½ A.M.	S.	42 13		E.N.E.	·591	
			11 15 A.M.	N.	34 36		N.E. by E.	·591	
	−20 24	345 10	Noon.	S. and N.	59 48			·586 ·590	·810
			3 P.M.	weight 1 grain.	18 9	74	N.E. ½ E.	·589	
	−20 6	345 22	5 30 P.M.	weight 1 grain.	18 7		N.E. by E. ½ E.	·590	
10.			10 30 A.M.	S.	42 0	76	N.E. ½ E.	·596	
			11 15 A.M.	N.	34 7			·602	
	−18 57	345 45	Noon.	S. and N.	59 9			·595 ·595	·817
			0 30 P.M.	weight 1 grain.	18 3	75	N.N.E. ½ E.	·592	
	−18 49	345 48	3 P.M.	weight 1 grain.	18 6	75	N.E.	·591	

TABLE I. (Continued.)

1840.	Position.		Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity.		
	Lat.	Long. E.						London = 1·000.		= 1·372
			h m		° ′					
Jan. 11.	−17 39	346 10	10 30 A.M.	S.	41 54	78	N.E. by E.	·598		
			11 35 A.M.	N.	34 0		N.N.E.	·605		
	−17 33	346 13	Noon.	S. and N.	59 10		N.E. by E.	·595	·597	·820
			3 P.M.	weight 1 grain.	18 0	72	E.N.E.	·594		
	−17 19	346 21	6 P.M.	weight 1 grain.	17 57	70	S.	·595		
12.			11 30 A.M.	S.	41 54	76	N.E. by E.	·598		
	−17 11	346 40	Noon.	N.	34 43			·588		
			0 30 P.M.	S. and N.	59 7			·596	·595	·817
			2 P.M.	weight 1 grain.	17 55		S.	·597		
13.			11 0 A.M.	S.	42 9		E. by N.	·592		
			11 30 A.M.	N.	34 20		N.E.	·597		
	−16 35	347 13	Noon.	S. and N.	59 18		E. by N.	·593	·594	·816
			2 P.M.	weight 1 grain.	17 58	74	N.E.	·595		
			2 30 P.M.	weight 1 grain.	17 59			·595		
	−16 25	347 22	3 30 P.M.	weight 1½ grain.	27 43			·592		
14.			10 30 A.M.	S.	42 6	76	N.E. by E. ½ E.	·594		
			11 15 A.M.	N.	34 22			·596		
	−15 19	348 0	Noon.	S. and N.	59 9			·596	·598	·821
			2 30 P.M.	weight 1 grain.	17 55			·597		
	−15 12	348 02	3 00 P.M.	weight 1½ grain.	27 6			·606		
15.			11 30	S.	42 18			·589		
	−15 20	348 07	Noon.	N.	34 30			·593	·592	·813
			0 30 P.M.	S. and N.	59 21			·594		
16.			10 30 A.M.	S.	41 53		S.S.W.	·598		
			11 15 A.M.	N.	34 20			·597		
	−15 49	348 09	Noon.	S. and N.	58 53			·600		
			1 P.M.	weight 1 grain.	17 56	76		·596	·599	
				weight 1 grain.	17 50			·599		
				weight 2 grains.	38 16			·600		
				S.	42 26		E. by N. ¼ N.	·585		·594 ·815
				N.	34 49			·587		
				S. and N.	59 22			·593	·590	
				weight 1 grain.	18 14	76		·587		
				weight 1 grain.	18 7			·590		
				weight 2 grains.	38 31			·597		
17.			3 P.M.	S.	42 19		E.	·588		
	−15 30	348 51	3 30 P.M.	N.	35 4			·582		
			4 0 P.M.	S. and N.	59 38			·589	·589	·810
				weight 1 grain.	18 0			·594		
18.	−14 37	349 30	9 30 A.M.	S.	42 12		N.E. by E.	·591		
			11 A.M.	S.	41 53		S. by W.	·598		
			11 20 A.M.	S.	42 0		S.W. by W.	·596		
			11 40 A.M.	S.	41 51		N. by E.	·599		
	−14 36	349 31	Noon.	S.	41 57		N.E. by E.	·596		
			0 30 P.M.	N.	34 30			·593	·595	·816
			1 0 P.M.	S. and N.	59 31			·591		
	−14 31	349 39	2 0 P.M.	weight 1 grain.	17 55	76		·597		
			2 30 P.M.	weight 1 grain.	17 56			·596		
			3 P.M.	weight 2 grains.	38 25			·598		
	−14 27	349 50	4 P.M.	weight 2 grains.	38 28			·597		
19.	−13 39	350 29	Noon.	S.	42 1		E. by N.	·596		
			3 P.M.	S.	41 52		S. by W. ½ W.	·598	·599	·822
	−13 35	350 36	2 P.M.	weight 1 grain.	17 41	76	S.S.W.	·604		
20.			10 30 A.M.	S.	42 28		E. ¼ N.	·584		
			11 15 A.M.	N.	34 19			·597		
	−14 19	350 33	Noon.	S. and N.	59 29			·591	·592	·813
				weight 1 grain.	17 55			·597		

Table I. (Continued.)

1840.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.	Intensity.	= 1·372.
			h. m.							
Jan. 21.	−14 51	350 31		S.	42 16	°	W.	·589		
				S.	42 7		N.W.	·593		
				S.	41 44		N.	·601		
				S.	42 6		N.E.	·593	·594	·815
				S.	42 15		E.	·589		
				weight 1 grain.	17 52			·598		
22.			11 A.M.	S.	41 51	75	S.W.	·599		
	−14 8	351 31	Noon.	weight 1 grain.	17 41			·604	·601	·825
				S.	41 52		N.E.	·598		
				weight 1 grain	17 45	67		·601		
23.			11 A.M.	S.	41 46			·601	·600	·823
	−13 43	352 01	Noon.	weight 1 grain.	17 50	70	S. by W. ½ W.	·599		
24.			10 30 A.M.	S.	41 47			·601		
			11 A.M.	N.	33 54			·607		
	−14 26	351 57	Noon.	S. and N.	58 36			·605	·601	·825
			0 15 P.M.	weight 1 grain.	17 54	77	S.	·597		
				weight 1 grain.	17 56			·596		
25.			10 15 A.M.	S.	41 47	77	S. by W.	·601		
	−15 3	351 54	Noon.	N.	33 59			·605	·601	·825
				S. and N.	58 44			·603		
			0 30 P.M.	weight 1 grain.	17 57	77		·596		
26.			11 A.M.	S.	41 51	78	S. by W.	·599	·597	·819
	−15 23	352 6	Noon.	weight 1 grain.	17 59			·595		
27.	−15 17	352 35	10 A.M.	S.	41 54	77	S.	·598	·598	·820
			11 A.M.	weight 1 grain.	17 55			·597		
28.	−15 19	353 13	10 A.M.	S.	42 1	76	E.N.E.	·595	·598	·820
				weight 1 grain.	17 48			·601		
29.			10 30 A.M.	S.	41 40	78	S.S.W.	·604	·604	·829
	−15 7	353 44	Noon.	weight 1 grain.	17 40			·605		
30.			11 0 A.M.	S.	41 46	77	S. ½ W.	·601	·601	·825
	−15 5	354 8	Noon.	weight 1 grain.	17 48		S. by W.	·601		
Feb. 3.	−15 55	354 17		S.	41 26			·610		
				S. and N.	58 18			·610		
				N.	33 45		Observed	·611	·611	·838
	Sister's Walk, James Town. St. Helena.			weight 1 grain.	17 43	81	on shore.	·603		
				weight 1½ grain.	26 36			·617		
				weight 2 grains.	37 13			·615		
5.				S.	42 35			·581		
				S. and N.	59 56			·584		
	Longwood. St. Helena.			N.	34 53		Observed	·585	·586	·804
				weight 1 grain.	18 13	69·7	on shore.	·587		
				weight 1½ grain.	27 17			·601		
				weight 2 grains.	39 52			·579		
6.	St. Helena.		1 P.M.	S.	42 23	79	W.	·586		
				S.	42 26		N.W.	·585		
				S.	41 47		N.	·601		
				S.	41 52		N.E.	·599		
				S.	42 20		W.	·587	·591	·811
				S.	42 0		S.W.	·595		
				S.	42 19		S.	·587		
				S.	42 11		S.E.	·592		
				S.	42 19		E.	·587		
10.	−17 22	353 30	11 30 A.M.	S.	41 49	77	S.S.W. ½ W.	·601	·600	·823
	−17 30	353 26	5 P.M.	S.	41 51	74	S.W. ½ S.	·599		
11.			11 A.M.	S.	41 51			·599		
	−18 46	352 46	Noon.	weight 1 grain.	17 32	76	S.S.W. ½ W.	·609	·603	·827
			4 P.M.	S.	41 46			·601		
	−19 1	352 44	4 30 P.M.	S.	41 43			·603		

TABLE I. (Continued.)

1840.	Position.		Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity.		
	Lat.	Long. E.						London = 1·000.		= 1·372.
			h m		° ′	°				
Feb. 12.	−20 41	352 0		S.	41 56	77	S.S.W.	·597		
				S and N.	58 41			·604		
				N.	34 29	76		·594		
			Noon.	weight 1 grain.	17 28	76	S.S.W. ½ W.	·612	·600	·823
			1 12 P.M.	weight 1 grain.	17 36			·607		
			1 30 P.M.	S.	41 57			·597		
			6 P.M.	S.	41 2	74	S.W. ½ W.	·597		
	−21 1	351 49	6 30 P.M.	S.	41 4	72	S.W. by S.	·596		
13.	−21 52	351 31	10 A.M.	S.	40 57	72	S. by E.	·599		
			10 30	S.	40 57	75		·599		
			10 45	S. and N.	57 34	76		·599	·599	·821
			11 0	N.	34 1			·605		
			11 30	S.	41 0	77	S.	·598		
	−22 12	351 23	Noon.	weight 1 grain.	18 1			·594		
			1 0 P.M.	weight 1 grain.	18 0	74	S. by W.	·594		
	−22 19	351 22	3 0	S.	41 4	74		·596		
	−22 23	351 22	5 0	S.	41 11	74		·594	·596	·818
			5 20	S.	41 5			·595		
			6 30	S.	40 56	73		·599		
14.	−23 33	351 10	7 A.M.	S.	40 41		S.S.W.	·604		
			8 30	S.	40 58	77	W.	·599		
	−23 37	351 0	9 30	S.	41 0			·595	·599	·821
			10 0	S. and N.	57 45			·597		
			10 40	N.	34 12			·599		
	−23 42	350 44	Noon.	weight 1 grain.	17 56			·596		
			1 30 P.M.	S.	40 58	78	E.	·599		
	−23 47	350 28	3 0	S.	41 5	76	W.	·595	·596	·818
			4 0	weight 1 grain.	18 0	75		·594		
	−23 51	350 16	5 30	S.	41 4	74		·596		
15.	−24 31	348 48	9 A.M.	S.	41 7	77	W.	·595		
			10	weight 1 grain.	17 50	78		·600		
			10 30	weight 1 grain.	17 51	78		·599		
			11 00	S.	41 12	80		·594	·596	·818
			11 30	S.	41 4	80		·596		
	−24 36	348 30	Noon.	S.	41 10	81		·595		
	−24 39	348 20	2 30 P.M.	S.	41 2	77		·597		
	−24 42	348 17	4 0	weight 1 grain.	17 45	74		·602		
			5 20	weight 1 grain.	17 45	75		·602		
	−24 42	348 10	6 0	S.	40 59	75		·598	·598	·820
			7 0	S.	41 12	74		·594		
	−25 0	348 0	Midnight.	S.	41 4	73		·596		
			0 40	weight 1 grain.	17 56	73	S.W.	·596		
16.	−25 15	347 59	6 A.M.	weight 1 grain.	17 51	72		·599		
			7	S.	40 49	73		·601		
			11	S.	40 57	80		·599	·598	·820
			11 30	S. and N.	58 13			·591		
	−25 24	347 49	Noon.	N.	34 9			·602		
			0 30 P.M.	weight 1 grain.	17 47	81		·602		
			1″ 0	weight 1½ grain.	27 18			·602		
			1 30	weight 2 grains.	38 11			·601	·605	·829
	−25 38	347 41	6 0	S.	40 13	76	S.W. by S.	·613		
			6 30	weight 1 grain.	17 36			·607		
17.	−26 8	347 03	10 A.M.	S.	40 50	77	W.	·601		
			10 30	S.	41 10	78	E.	·594	·602	·826
	−26 8	347 03	5 P.M.	S.	40 24	75	S. by E.	·609		
18.	−27 0	346 33	10 A.M.	S.	40 20	78	S.S.W.	·611		
			10 40	S. and N.	57 11			·605		
			11 20	N.	33 19			·621	·615	·844
	−27 6	346 32	Noon.	weight 1 grain.	17 7			·624		

TABLE I. (Continued.)

1840.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.	Intensity. = 1·372.
Feb. 19.	−27° 55′	346° 41′	10 A.M.	S.	40° 28′	78°	S.E.	·610	
			10 30	weight 1 grain.	17 27			·612	
			11 10	weight 1½ grain.	27 20			·601	·607 ·834
	−27 57	346 46	Noon.	weight 2 grains.	37 47			·607	
20.			10 30 A.M.	S.	40 17	77	S.E.	·612	
			11 10	S. and N.	57 34			·599	
			11 40	N.	33 26			·618	·609 ·836
	−28 57	348 32	Noon.	weight 1 grain.	17 29	79		·611	
	−29 8	349 0	5 P.M.	S.	40 35			·606	
21.	−30 1	351 29	9 30 A.M.	S.	40 1		S E.	·618	
			10	weight 1 grain.	16 58			·629	·622 ·852
	−30 28	351 45	5 30 P.M.	S.	40 1		S.E. ½ E.	·618	
22.	−30 59	353 23	7 A.M.	S.	39 48			·621	
	−31 7	353 46	10	S.	39 48			·621	
			10 30	S. and N.	57 7			·605	
			11 00	N.	32 51			·632	·619 ·849
			11 30	weight 1 grain.	17 25			·610	
	−31 10	354 0	Noon.	weight 1½ grain.	26 27			·619	
	−31 17	354 34	4 40 P.M.	S.	39 32			·627	
23.	−31 46	356 38	11 30 A.M.	S.	39 4		S.E. by E.	·636	·872
24.	−31 13	358 38	10 A.M.	S.	39 9		E. ½ S.	·635	
			10 30	S.	39 7		E. by S.	·635	·636 ·872
			11 00	weight 1 grain.	16 43			·638	
25.	−30 17	359 40	6 A.M.	S.	39 12		E.	·634	
			6 30	weight 1 grain.	17 1			·627	
			7 0	weight 1 grain.	17 0			·628	
	−30 18	359 55	10 0	S.	38 20		S.E.	·652	·640 ·878
			10 40	N.	32 6			·652	
			11 10	S. and N.	55 37			·630	
	−30 14	359 55	Noon.	weight 1 grain.	16 29			·647	
	−30 30	359 48	5 30 P.M.	S.	38 22		S.W.	·653	
26.	−31 7	359 27	10 A.M.	S.	38 7		S. ½ W.	·658	
			10 20	S. and N.	55 16			·636	
			10 45	N.	32 3		S. by W.	·653	·647 ·888
			11 10	weight 1 grain.	16 50			·634	
			11 40	S.	38 5		S.W.	·658	
	−31 9	359 24	Noon.	S.	38 31		W.	·644	
27.	−31 18	359 48	10 A.M.	S.	38 36	71	S.E.	·645	
			10 30	S. and N.	55 27			·633	·638 ·876
			11 20	N.	32 13			·649	
	−31 20	359 57	Noon.	weight 1 grain.	17 0			·627	
28.	−32 1	2 17	10 30 A.M.	S.	38 33	72	S.E.	·645	
			11 0	S.	38 34			·645	·645 ·886
29.	−32 39	4 18	11 A.M.	S.	37 43	70	S.E.	·666	·915
March 1.	−33 9	5 48	11 00	S.	37 52·5	71	S.E.	·663	
			11 30	S. and N.	54 3·5	71		·657	·665 ·913
			Noon.	N.	31 16	71		·674	
2.	−33 23	7 41	6 40 A.M.	S.	37 39·7	70		·667	
			11 0	S.	37 23·8	71		·672	
	−33 27	7 20	5 0 P.M.	S.	37 27·7	71		·671	
			5 15	S. and N.	53 10·5	71	S.E. ½ E.	·674	·672 ·922
			5 30	N.	30 52·5	71		·686	
			5 50	weight 1 grain.	15 56·2	70		·667	
			6 15	weight 1 grain.	15 57·8	70		·668	
3.	−33 21	9 4	3 40 P.M.	S.	37 12		W.S.W.	·678	·675 ·925
			4 30	S.	37 28		E.N.E.	·671	

TABLE I. (Continued.)

1840.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.	Intensity.	= 1·372.
			h m		° ′ ″					
March 4.	−33 8	10 11	10 0 A.M.	S.	37 16·7	66		·677		
			10 30	N. and S.	53 20			·670	·679	·932
			11 0	N.	31 1·5		S.E.	·681		
			Noon.	weight 1 grain.	15 28	67		·687		
5.	−33 11	11 57	6 30 A.M.	S.	37 11	68	E.S.E.	·678		
			9 30	S.	37 11·7	68	S.E. ½ S.	·678	·682	·935
			11 0	weight 1 grain.	15 30·2	68	S.E.	·686		
			11 30	weight 1 grain.	15 32·2			·685		
6.	−32 57	14 00	10 A.M.	S.	36 39·5	69	S.E. by E.	·691		·947
7.	−32 33	15 24	3 15 P.M.	S.	36 25·4	72	E.S.E.	·697		·956
8.	−32 17	17 0	Noon.	S.	36 13	68	S.E. ½ S.	·702		·963
9.	−32 31	17 41	Noon.	S.	36 33·2	61	W. by N. ½ N.	·693		·951
10.	−32 45	16 37	0 30 P.M.	S.	36 29·5	63		·694		·952
11.	−33 3	16 46	10 0 A.M.	S.	36 2·4		S.E.	·707		·970
12.	−33 17	16 51	10 0 A.M.	S.	35 54·2	69		·711		
			10 30	S.	35 47·2	69	S.E. by S.	·713		
	−33 17	17 00	3 P.M.	S.	35 55·5	72		·711		
			3 30	S. and N.	50 56·6	72		·719	·720	·988
			3 50	N.	29 19·5	72	S. by E. ½ E.	·733		
			4 10	weight 1 grain.	14 36·7	71		·727		
			4 30	weight 1 grain.	14 42	71		·723		
13.			10 A.M.	S.	35 20	65		·723		
			10 30	S. and N.	50 57·2	65		·720		
			11 0	N.	29 28	65		·729		
			11 30	weight 1 grain.	14 42·2	64		·722		
	−33 56	18 10	Noon.	weight 1½ grain.	22 0·2	64		·735		
			0 30 P.M.	S.	35 20·2	65	S. by W.	·723	·725	·995
			1 30	S.	35 21	65		·723		
			1 50	S. and N.	50 55·2	66		·720		
			2 10	N.	29 26	66		·730		
			2 30	weight 1 grain.	14 40·3	66		·724		
14.	−34 20	17 57	10 A.M.	S.	35 38·9	61	E.S.E.	·715		·981
17.			10 A.M.	S.	35 34·5	71		·717		
			10 20	S. and N.	51 9·7	71		·715		
			10 40	N.	29 37·7	71	S.E.	·724		
			0 30 P.M.	weight 1 grain.	14 39·7	71		·724		
			1 0	weight 1 grain.	14 34·2	71		·729	·716	·982
				S.	35 46·2		N.E.	·712		
				S.	36 1·5		E.N.E.	·706		
				S.	35 59·5		E.	·706		
				S.	35 53·2		E.S.E.	·710		
18.	Single Anchor, Simon's Bay.			S.	35 39·4			·715		
				S.	35 17		S.E.	·724		
19.	Moored in Simon's Bay.			S.	35 47·6		E.S.E.	·711		
				S.	35 35		S.S.E.	·717		
				S.	35 25·8		S.	·721		
				S.	35 1		S.S.W.	·733		
			Noon.	S.	34 56·2		S.W.	·735		
				S.	35 45		W.S.W.	·713		
				S.	35 24		W.	·722		
				S.	35 31·8		W.N.W.	·718		
				S.	35 35		N.W.	·717		
				S.	35 24·8		N.N.W.	·722		
			4 P.M.	S.	35 26·3		N.	·721		
			6 P.M.	S.	35 39·2		N.N.E.	·715		
20.	Admiral's jetty.			S.	35 39·7	79	On shore.	·715		·981

TABLE I. (Continued.)

1840.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.	Intensity. = 1·372
					° ′ ″	°			
				S.	35 09·1	79	S.	·729	
March 20.	Moored in Simon's Bay.			S.	35 16·2	76	S.W.	·726	
	34 11	18 26		S.	35 39·1		W.	·715	
				S.	35 50·7		N.W.	·710	
				S.	35 45·6		N.	·712	
				S.	35 48·9		N.E.	·711	
				S.	35 38·6		E.	·715	
	Block House Simon's Bay.			S.	35 39·3	80·5		·715	
				S. and N.	51 06·4	80·5		·716	
			Noon.	N.	29 54·2	80·5		·714	
				weight 1 grain.	14 48·9	87·5		·719	
				weight 1½ grain.	22 57·8	87·5	Observed	·709	
25.			8 A.M.	S.	35 40·8	80·5	on shore.	·715	·981
				S. and N.	51 13·5	80·5		·714	
				N.	29 51·5	80·5		·716	
				weight 1 grain.	15 20·6	92		·695*	
				weight 1½ grain.	22 42·4	91		·715	

Observations in the Terror.—The observations in the Terror were made with a Fox's needle of four inches diameter; one of equal size with that in the Erebus, which was not ready when the Expedition sailed, having been sent out subsequently, and received by Captain CROZIER, at Van Diemen Island, in August 1840. An instrument of only two inches radius, for the purpose of determining both the dip and intensity at sea, might previously have been regarded by many persons as scarcely more than a philosophical toy; and as little likely to yield results having the precision which is now required in such determinations. It has, however, in Captain CROZIER's hands, fully justified the expectations which Mr. Fox, from his own experiments with it, had ventured to entertain. On land, the instruments of the Erebus and Terror are, for the most part, as far as they have yet reached us, nearly identical in their results. Confining our attention to the *intensity* as the subject immediately before us, the intensities at James Town in St. Helena, and at Longwood in the same island, measured by the instruments of the two ships, the days and spots of observation being the same, are by the Erebus in the proportion of ·586 at Longwood to ·611 at James Town, and by the Terror as ·587 to ·611. The agreement is in this case the more valuable, because we are justified by it in ascribing the difference thus found between places so geographically near to each other, to a really existing difference (viz. to station error), rather than to accident or to observation error, as might have been done, had only a single instrument been used. A similar accord in the determinations of the two instruments is shown by the results at the Cape of Good Hope and Kerguelen Island, which, though more properly belonging to the next section, may be instanced here in evidence of the confirmation which the two instruments

* Omitted in the mean.

mutually afford each other; the Erebus making the intensity on shore at Christmas Harbour, in Kerguelen Island, to be as 1·068 to 0·715 at Simon's Bay, and the Terror as 1·0675 to 0·715. At sea, where in consequence of the motion of the ship, the inferior size of the four-inch instrument cannot be compensated by additional time given to the reading, or by other arrangments conducing to minute accuracy, the probable error of a single result appears, as might be expected, to be somewhat greater with the four inch-than with the 7½-inch needle; but, with this reservation, the observations made at sea with the two instruments, when the ships were in company, are highly confirmatory each of the other.

The table which has been received from the Terror contains almost daily observations from the 1st of January 1840 until her arrival at the Cape of Good Hope in the following March. The intensities were observed both by deflectors and by constant weights, which latter, in the four-inch instrument, were ·5 and ·3 of a grain. St. Helena is the only land station observed at in the passage; the intensities observed at sea have therefore been computed relatively to the observations at James Town St. Helena, taken as a base station; and the value of the intensity at James Town has been taken as determined by the Erebus, viz. as 0·611, to unity in London, or as 0·838 to 1·372 in London. The values of w' for the Terror's deflectors N. and S, required, instead of a table of coercing weights, in computing the intensities when the deflectors were used, have been derived by the method already explained. Tables of these values for each degree of deflection are subjoined: neither on a careful examination of the observations, nor in the process of forming these tables, does there appear any reason to suppose that the deflectors or the needle sustained any change in magnetic condition during the period embraced by the observations under notice.

Values of w', Terror's Deflectors.

N.		S.	
°	gr.	°	gr.
38	= ·837	33	= ·732
39	= ·828	34	= ·726
40	= ·819	35	= ·721
41	= ·811	36	= ·716
42	= ·803	37	= ·711
43	= ·797	38	= ·707
44	= ·7925	39	= ·703
45	= ·791	40	= ·700
46	= ·7895		
47	= ·7885		

With the values of w' taken from this Table, the intensities at sea are obtained relatively to 0·611 at St. Helena (London = 1), by the formula

$$I' = \cdot 5393\, w' \operatorname{cosec} v'.$$

Table II.

Observations of the Magnetic Intensity on Shore, and on Board Her Majesty's Ship Terror, with a four-inch Fox's Needle.

1840.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.		= 1·372.
			h m		° ′	°				
Jan. 1.	−28 17	339 59	9 25 A.M.	N.	46 27	77	E.S.E.	·587		
				S.	38 54	77		·604	·591	·812
				weight ·5 grain.	26 50·5	77		·597		
				weight ·3 grain.	16 20·0	77		·575		
2.	−28 03	341 41	9 50 A.M.	N.	46 02·1	76	E. ½ N.	·593		
				S.	39 57·0	76		·588	·587	·808
				weight ·5 grain.	27 31·0	76		·583		
				weight ·3 grain.	16 08·0	76		·582		
2.	−27 48	341 53	5 0 P.M.	N.	45 35	76	N.E. ½ E.	·596		
				S.	38 57	76		·603	·597	·820
				weight ·5 grain.	27 18·5	76		·587		
				weight ·3 grain.	15 33	76		·603		
3.	−27 26	342 28	9 40 A.M.	N.	45 40	76	N.E. by E.	·595		
				S.	39 01	76		·602	·595	·817
				weight ·5 grain.	27 20	76		·587		
				weight ·3 grain.	15 41	76		·598		
4.	−26 50	342 58	9 40 A.M.	N.	45 03	76	N.E.	·602		
				S.	39 03	76		·601	·600	·824
				weight ·5 grain.	26 55	76		·595		
				weight ·3 grain.	15 33	76		·603		
5.	−25 50	342 55	10 00 A.M.	N.	45 25	76	N.E. by N.	·598		
				S.	39 07·5	76		·600	·603	·828
				weight ·5 grain.	26 18	76		·607		
				weight ·3 grain.	15 28	76		·607		
6.	−24 28	343 0	9 50 A.M.	N.	45 27	76		·598		
				S.	39 26	76		·596	·593	·815
				weight ·5 grain.	26 27	76		·605		
				weight ·3 grain.	16 27	76		·571		
7.	−22 56	343 30	10 00 A.M.	N.	45 34	73	N.E. ½ N.	·596		
				S.	40 10	73		·585	·594	·816
				weight ·5 grain.	26 57	73		·594		
				weight ·3 grain.	15 34	73		·602		
8.	−21 43	344 13	10 0 A.M.	N.	46 06	76	E.N.E.	·591		
				S.	41 05·5	76		·574	·589	·810
				weight ·5 grain.	26 32	76		·603		
				weight ·3 grain.	16 00·5	76		·586		
9.	−20 31	345 05	9 45 A.M.	N.	46 21	74	E. ½ N.	·588		
				S.	40 23	74		·583	·583	·800
				weight ·5 grain.	27 48	74		·578		
				weight ·3 grain.	16 07	74		·583		
10.	−19 12	345 45	9 00 A.M.	N.	46 04	76	N.N.E.	·591		
				S.	40 02	76		·587	·593	·815
				weight ·5 grain.	26 39	76		·600		
				weight ·3 grain.	15 40	76		·593		
11.	−17 44	346 10	10 00 A.M.	N.	45 51·5	78	N.E.	·594		
				S.	39 48	78		·590		
				S.	39 21	78		·597	·594	·816
				weight ·5 grain.	26 51	78		·595		
				weight ·3 grain.	15 47·5	78		·594		
12.	−17 23	346 29	9 00 A.M.	N.	46 05	76	N.E. by E. ½ E.	·591		
				S.	40 25	76		·583	·593	·815
				weight ·5 grain.	26 53	76		·596		
				weight ·3 grain.	15 38	76		·600		

Table II. (Continued.)

1840.	Position. Lat.	Position. Long. E.	Time of day. h m	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.	Intensity. = 1·372.
Jan. 13.	−16° 43′	347° 02′	10 0 A.M.	N.	45° 56′	74°	E. ½ N.	·593	
				N.	45 39	74		·595	
				S.	39 32	74		·594	·592 ·812
				S.	39 45	74		·591	
				weight ·5 grain.	27 07	74		·591	
				weight ·3 grain.	15 55·5	74		·590	
14.	−15 25	347 50	9 40 A.M.	N.	46 50	76	E.N.E.	·583	
				S.	39 17	76		·598	·595 ·816
				weight ·5 grain.	27 01	76		·593	
				weight ·3 grain.	15 26	76		·608	
15.	−15 30	347 58	9 10 A.M.	N.	46 18	76	N.E. by E.	·588	
				S.	39 04	76		·601	·598 ·820
				weight ·5 grain.	27 20	76		·586	
				weight ·3 grain.	15 12	76		·617	
16.	−15 41	348 09	9 10 A.M.	N.	45 26	76	S.W. by S.	·598	
				S.	38 12	76		·616	·617 ·847
				weight ·5 grain.	25 54	76		·616	
				weight ·3 grain.	14 40·5	76		·638	
17.	−15 37	348 32	9 45 A.M.	N	46 25	76	E. by N.	·587	
				S.	39 43	76		·591	·597 ·818
				weight ·5 grain.	26 27	76		·604	
				weight ·3 grain.	15 32	76		·604	
18.	−14 45	349 22	9 45 A.M.	N.	46 10	76		·590	
				S.	39 24	76		·596	·598 ·820
				weight ·5 grain.	26 40	76		·599	
				weight ·3 grain.	15 24	76		·609	
19.	−13 44	350 20	9 15 A.M.	N.	45 19	76		·599	
				S.	39 01	76		·602	·604 ·829
				weight ·5 grain.	26 52	76		·595	
				weight ·3 grain.	15 08	76		·619	
20.	−14 28	350 19	9 20 A.M.	N.	45 39	76	S.W. ½ W.	·595	
				S.	38 49	76		·605	·605 ·830
				weight ·5 grain.	26 31	76		·603	
				weight ·3 grain.	15 09	76		·619	
20.	−14 26	350 21	10 15 A.M.	N.	46 26	76	E.	·587	
				S.	39 29	76		·595	·602 ·826
				weight ·5 grain.	27 14	76		·588	
				weight ·3 grain.	14 50	76		·637	
21.	−14 54	350 25	8 50 A.M.	N.	46 09	76	S.W. by S.	·590	
				S.	39 04	76		·601	·609 ·836
				weight ·5 grain.	25 59	76		·614	
				weight ·3 grain.	14 51	76		·631	
21.	−14 53	350 26	9 50 A.M.	N.	46 06	76	E.N.E.	·591	
				S.	39 14	76		·598	·594 ·815
				weight ·5 grain.	27 15	76		·588	
				weight ·3 grain.	15 36	76		·601	
22.	−14 08	350 28	9 40 A.M.	N.	45 23	76	S.W. by S.	·598	
				S.	38 59	76		·602	·609 ·836
				weight ·5 grain.	26 05·5	76		·612	
				weight ·3 grain.	14 58	76		·626	
23.	−13 36	352 0	9 45 A.M.	N.	45 32	76		·597	
				S.	38 37	76		·609	·607 ·834
				weight ·5 grain.	26 39	76		·600	
				weight ·3 grain.	15 07	76		·620	
24.	−14 19	351 53	9 10 A.M.	N.	45 21	76	S. ½ W.	·599	
				S.	38 19	76		·613	·608 ·835
				weight ·5 grain.	26 33	76		·602	
				weight ·3 grain.	15 08	76		·619	

Table II. (Continued.)

1840.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.	Intensity. = 1·372.
	° ′	° ′	h m		° ′	°			
Jan. 25.	—14 55	351 52	9 15 A.M.	N.	45 36	77	S.S.W.	·596	
				S.	38 40	77		·608	
				weight ·5 grain.	26 39	77		·600 ·604	·829
				weight ·3 grain.	15 21	77		·611	
26.	—15 14	352 03	9 15 A.M.	N.	45 08	77		·601	
				S.	38 32	77		·610	
				weight ·5 grain.	26 25	77		·607 ·605	·830
				weight ·3 grain.	15 31	77		·604	
27.	—15 11	352 32	9 15 A.M.	N.	45 31·5	77	E.N.E.	·597	
			9 15	S.	38 27	77		·611	
			9 15	weight ·5 grain.	26 33	77		·602 ·601	·825
			9 15	weight ·3 grain.	15 45	77		·595	
27.	—15 13	352 33	10 20 A.M.	N.	45 0	77	S. ½ W.	·603	
				S.	38 41	77		·608	
				weight ·5 grain.	25 40	77		·621 ·611	·838
				weight ·3 grain.	15 18·5	77		·612	
28.	—15 19	353 6	9 40 A.M.	N.	45 17	76	S.S.W.	·600	
				S.	38 30	76		·610	
				weight ·5 grain.	26 29	76		·603 ·607	·834
				weight ·3 grain.	15 30	76		·615	
28.	—15 20	353 07	10 40 A.M.	N.	45 29	76	E.N.E.	·597	
				S.	39 02	76		·602	
				weight ·5 grain.	25 56	76		·604 ·604	·829
				weight ·3 grain.	15 18	76		·613	
29.	—15 00	353 36	9 30 A.M.	N.	45 58	78	N.E. by E.	·592	
				S.	39 14	78		·599 ·597	·818
				weight ·3 grain.	15 36	78		·601	
29.	—15 02	353 36	10 45 A.M.	N.	45 39	78	S. ½ W.	·595	
				S.	38 28	78		·611	
				weight ·5 grain.	26 19·5	78		·607 ·600	·824
				weight ·3 grain.	15 58	78		·588	
30.	—15 10	354 5	10 10 A.M.	N.	45 47	77	S.S.W.	·594	
				S.	38 37	77		·609	
				weight ·5 grain.	26 12	77		·609 ·608	·835
				weight ·3 grain.	15 10	77		·618	
31.	—15 40	354 19	9 15 A.M.	N.	45 03	78	S. by W.	·603	
				S.	39 17	78		·598	
				weight ·5 grain.	27 02·4	78		·592 ·598	·820
				weight ·3 grain.	15 41	78		·598	
Feb. 3.	—15 55	354 17	0 45 P.M.	N.	44 21·2	81		·611	
	Sister's Walk, St. Helena.			weight ·5 grain.	26 09·8	81		·611 ·611	·838
				weight ·3 grain.	15 21·7	81		·611	
5.	Longwood.			N.	46 07	70	Observed on shore.	·591	
				weight ·5 grain.	27 10	70		·589 ·587	·805
				weight ·5 grain.	27 06·5	70			
				weight ·3 grain.	16 07·1	70		·582	
				weight ·3 grain.	16 06·4	70			
10.	—17 14	353 33	9 40 A.M.	N.	44 42	77	S.W. by S.	·606	
				S.	39 09	77		·600	
				S.	38 47	77		·606 ·600	·824
				weight ·5 grain.	26 46	77		·597	
				weight ·3 grain.	15 55	77		·590	
11.	18 33	352 52	9 15 A.M.	N.	45 12	76	S.W.	·601	
				S.	39 04	76		·601 ·601	·825
12.	—20 22	352 06	9 20 A.M.	N.	45 10	77	S.S.W. ½ W.	·601	
				S.	38 17	77		·598	
				weight ·5 grain.	26 20	77		·607 ·598	·820
				weight ·3 grain.	16 02	77		·585	

Table II. (Continued.)

1840.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.	Intensity. = 1·372.
	° ′	° ′	h m		° ′				
Feb. 13.	−21 55	351 33	9 10 A.M.	N.	44 52·5	76	S.S.E.		
			9 24 A.M.	N.	45 04·3	76			
	−21 57	351 31	9 55 A.M.	N.	45 03·6	76			
			10 10 A.M.	N.	45 03·2	76		·603	·828
	−22 03	351 30	10 24 A.M.	N.	45 01·2	76			
			10 36 A.M.	N.	45 01·3	76			
	−22 05	351 28	10 55 A.M.	N.	44 58·5	76			
			11 05 A.M.	N.	45 06·2	76			
	−22 07	351 27	1 20 P.M.	N.	45 07·5	76			
			1 35 P.M.	N.	45 03·8	76	S. by W.	·602	·826
	−22 15	351 26	1 55 P.M.	N.	45 03·6	76	S. ½ W.		
			2 10 P.M.	N.	45 10	76			
	−22 20	351 22	5 55 P.M.	N.	45 00·2	74			
			6 10 P.M.	N.	45 00·6	74			
14.	−23 32	350 58	9 00 A.M.	weight ·5 grain.	26 36	77	W.	·601	
				weight ·3 grain.	16 05	77		·584	
				S.	39 02	77		·602	
				N.	45 50	77			
			9 20 A.M.	N.	45 40	77			
	−23 14	350 44	11 35 A.M.	N.	45 46	77		·594	·594 ·815
			11 45 A.M.	N.	45 47	77			
	−23 48	350 27	3 40 P.M.	N.	45 52	77			
			4 00 P.M.	N.	45 47	77			
	−23 54	350 13	5 40	N.	45 40	77		·594	
			5 50	N.	45 49	77			
15.	−24 29	348 48	8 50 A.M.	weight ·5 grain.	27 08	77		·590	
			8 50 A.M.	weight ·3 grain.	16 14	77		·579	
			8 50 A.M.	S.	39 43·5	77		·591	
			8 50 A.M.	N.	45 24	77	W. by S.		
			8 58 A.M.	N.	45 26	77			
	−24 31	348 42	10 00 A.M.	N.	45 22	78		·598	·596 ·817
			10 15 A.M.	N.	45 29	78			
	−24 35	348 36	11 40 A.M.	N.	45 21	80	W. by N.		
			Noon.	N.	45 32·5	80			
	−24 39	348 24	3 40 P.M.	N.	45 38	76	W.		
			3 50 P.M.	N.	45 41	76		·596	
	−24 41	348 19	5 35 P.M.	N.	45 28	75			
			5 50 P.M.	N.	45 35	75	W.S.W.		
16.	−25 18	347 54	8 50 A.M.	N.	44 41	80	S.S.W.	·606	
			9 20 A.M.	N.	44 41	80		·606	
			9 20 A.M.	S.	38 48	80		·605	·599 ·822
			9 20 A.M.	weight ·5 grain.	26 26	80		·605	
			9 20 A.M.	weight ·3 grain.	16 12·5	80		·580	
17.	−26 03	347 07	8 40 A.M.	N.	45 05	77	W.S.W.	·602	
			9 30 A.M.	N.	45 01	77		·603	
			9 30 A.M.	S.	38 45	77		·606	·600 ·823
			9 30 A.M.	weight ·5 grain.	26 53	77		·593	
			9 30 A.M.	weight ·3 grain.	15 43·5	77		·597	
18.	−26 51	346 37	9 15 A.M.	N.	44 44·7	78	S.W. by S.	·606	
				S.	38 48·0	78		·605	·604 ·829
				weight ·5 grain.	27 13·7	78		·589	
				weight ·3 grain.	15 13·1	78		·616	
19.	−27 54	346 42	9 20 A.M.	N.	44 34·7	78	S.E.	·608	
				S.	38 01·9	78		·619	·607 ·834
				weight ·5 grain.	26 28·7	78		·604	
				weight ·3 grain.	15 46·9	78		·595	
20.	−28 47	348 15	9 30 A.M.	N.	44 11·2	77	S.E. ½ S.	·613	
				S.	38 18	77		·614	·615 ·844
				weight ·5 grain.	26 02	77		·613	
				weight ·3 grain.	15 08	77		·619	

TABLE II. (Continued.)

1840.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.		= 1·372.
	° ′	° ′	h m		° ′	°				
Feb. 21.	−29 56	350 42	8 45 A.M.	N.	44 24	79	S.E.	·610	·611	·838
				S.	38 28	79		·611		
22.	−31 00	353 40	9 20 A.M.	N.	43 18·5	79	S.E. ½ E.	·626	·625	·856
				S.	37 39·5	79		·625		
23.	−31 40	356 30	9 10 A.M.	N.	43 29·5	79	S.E. by E.	·622	·626	·857
				S	37 21·1	79		·630		
24.	−31 13	358 26	9 15 A.M.	N.	43 34	79	E. ½ S.	·621	·628	·862
				S.	37 03	79		·635		
25.	−30 10	359 53	9 00 A.M.	N.	43 14	75	E.N.E.	·627	·625	·858
				S.	37 33	75		·627		
				weight ·5 grain.	25 31	75		·625		
				weight ·3 grain.	15 04	75		·622		
25.	−30 12	359 54	10 00 A.M.	N.	43 04	75	S.S.W.	·629	·638	·876
				S.	36 23	75		·647		
26.	−31 07	359 28	9 20 A.M.	N.	42 21	71	S. by W.	·641	·640	·878
				S.	36 18	71		·649		
				weight ·5 grain.	25 21	71		·628		
				weight ·3 grain.	14 32·5	71		·644		
27.	−31 15	359 48	9 10 A.M.	N.	42 45·2	71	S E.	·634	·639	·876
				S.	37 01	71		·636		
				weight ·5 grain.	24 23	71		·651		
				weight ·3 grain.	14 45	71		·634		
28.	−31 57	2 02	9 00 A.M.	N.	42 15·6	72	S.E. ½ S.	·643	·647	·888
				S.	36 11·5	72		·651		
29.	−32 35	4 20	9 40 A.M.	N.	41 29·4	70		·656	·650	·892
				S.	36 33·4	70	S.E.	·644		
March 1.	−33 02	5 40	9 00 A.M.	N.	41 06	71		·664	·670	·919
				S.	34 59	71		·677		
2.	−33 20	7 32	9 10 A.M.	N.	41 01·5	71		·666	·668	·917
				S.	35 19	71		·671		
3.	−33 10	9 02	9 30 A.M.	N.	40 54·5	70	N.E.	·668	·673	·923
				S.	35 09·6	70		·674		
				S.	34 41·8	70		·683		
				weight ·5 grain.	23 39·3	70		·670		
				weight ·3 grain.	13 55·5	70		·673		
4.	−33 03	9 55	9 05 A.M.	N.	40 16·1	67	S.E. ½ S.	·681	·685	·940
				S.	34 24·2	67		·690		
5.	−33 08	11 43	9 15 A.M.	N.	39 45·5	68	S.E. by S.	·693	·698	·957
				S.	33 53·8	68		·702		
6.	−32 56	13 48	9 15 A.M.	N.	39 35·7	70	S.E. by E.	·696	·699	·959
				S.	33 51·1	70		·703		
7.	−32 14	15 20	9 30 A.M.	N.	39 10·5	70	E.S.E.	·705	·707	·970
				S.	32 35·7	70		·709		
8.	−32 16	16 52	9 20 A.M.	N.	39 17·2	68	S.E. ½ S.	·703	·711	·975
				S.	33 12	68		·719		
9.	−32 31	17 45	9 45 AM.	N.	39 49	61	N.W.	·691	·698	·957
				S.	33 43·2	61		·706		
10.	−32 44	16 27	9 00 A.M.	N.	38 32·9	63	S.E.	·720	·724	·994
				S.	32 51·6	63		·728		
11.	−33 01	16 41	9 20 A.M.	N.	39 03·7	69	S.E. ½ E.	·708	·712	·976
				S.	33 21·2	69		·716		
12.	−33 13	16 46	3 45 P.M.	N.	38 23·4	69	S.S.E.	·724	·732	1·004
				S.	32 18·1	69		·740		
13.	−33 52	18 04	9 0 A.M.	N.	38 35·6	65	S. by W.	·719	·722	·991
				S.	33 00	65		·725		
14.	−34 16	17 34	9 30 A.M.	N.	38 31·8	61	E. by N.	·721	·712	·976
				S.	33 50·7			·703		

Minimum Intensity.—In the passage from England to the Cape of Good Hope the Expedition traversed three times that large space of the Atlantic in which the magnetic intensity is less than in any other part of the surface of the globe; first in a southerly course, in and about the meridian of 330° E.; a second time in beating up to St. Helena, in and about the meridian of 345° E.; and a third time in the course from St. Helena to the Cape of Good Hope, in and about the meridian of 350° E.

Before we examine more particularly the results of the observations made during these traverses, it will be proper to clear them from the effects of the ship's iron, as far as the data furnished will enable us to do so.

It is obvious, on a simple inspection of the results in the tables, that, in the southern hemisphere, when the ship's head was on the points from S. E. to S.W., the intensity observed was generally slightly in excess, and on the contrary, when on the points from N.E. to N.W., slightly in defect; and that such was the case in both ships. At St. Helena and at the Cape of Good Hope, an endeavour was made to ascertain more precisely the effect of the ship's iron in modifying the results, by placing the ship's head successively on the principal points of the compass, and observing the intensity in each position. At St. Helena, the experiment failed, owing, apparently, to the disturbing influence of the island itself, which, even at the distance at which the vessels were anchored, was found to be sufficient to mask the local attraction of the ship, and to produce anomalies which were not experienced at sea. At the Cape, the geological character of the land interposed no such difficulty. The following Table shows the differences found at Simon's Bay between the intensity observed on each of the sixteen principal points of the compass, and the arithmetical mean of the whole. Each difference has the sign prefixed which would be required for a correction to the arithmetical mean. Allowing for discrepancies incidental to single observations, the general aspect of the differences is sufficiently systematic to justify us in regarding them as principally occasioned by the influence of the ship's iron.

Ship's head.	Corrections.		Mean of the two ships.	Ship's head.	Corrections.		Mean of the two ships.
	Erebus.	Terror.			Erebus.	Terror.	
E.	+ ·002	+ ·001	+ ·001	W.	− ·000	+ ·010	+ ·005
E.S.E.	+ ·006	+ ·004	+ ·005	W.N.W.	000	+ ·009	+ ·004
S.E.	− ·002	− ·004	− ·003	N.W.	+ ·005	+ ·012	+ ·008
S.S.E.	+ ·001	− ·004	− ·002	N.N.W.	− ·004	+ ·008	+ ·002
S.	− ·007	− ·015	− ·011	N.	+ ·002	+ ·012	+ ·007
S.S.W.	− ·015	− ·015	− ·015	N.N.E.	+ ·003	+ ·012	+ ·007
S.W.	− ·012	− ·007	− ·010	N.E.	+ ·007	+ ·004	+ ·005
W.S.W.	+ ·005	− ·004	000	E.N.E.		+ ·001	+ ·001

This experiment was repeated at Kerguelen Island, but with the ship's head placed only on the eight principal points: the season and weather were unfavourable, and the errors of observation were consequently greater than at the Cape; but the general indication is the same: the results are as follows:

Ship's head.	Differences from the mean.		Mean of the two ships.	Ship's head.	Differences from the mean.		Mean of the two ships.
	Erebus.	Terror.			Erebus.	Terror.	
E.	+ ·008	− ·003	+ ·002	W.	+ ·006	+ ·007	+ ·006
S.E.	− ·007	000	− ·003	N.W.	000	+ ·008	+ ·004
S.	− ·016	− ·027	− ·021	N.	+ ·007	+ ·005	+ ·006
S.W.	− ·014	+ ·001	− ·006	N.E.	+ ·014	+ ·008	+ ·011

The experiments at the Cape and Kerguelen Island agree in indicating the points of greatest disturbance to be from S.E. (through south) to S.W., causing an augmentation,—and from N.E. (through north) to N.W., causing a diminution,—in the regular magnetic intensity; the augmentation on the southerly points being rather greater than the diminution on the northerly, compensated by there being a greater number of the remaining points in defect than in excess; the latter points being affected in a minor degree. Considering that the differences shown in the two last Tables necessarily combine the errors of observation with the influence of local attraction, we may regard the effect of the ship's iron on the intensity needle as probably amounting, in extreme cases, to $\frac{1}{100}$th of the earth's magnetic force; but on much the greater number of points as probably far less than that amount. In Table III., which contains the results of the almost daily observations made in the Erebus between December 7, 1839, and February 29, 1840, in the space of the Atlantic comprised between the two portions of the isodynamic curve of 0·9, I have employed the following scale of correction*:

Ship's head		Ship's head	
S.W. by S. to S.E. by S.	− ·008	W. and E.	+ ·001
S.W. and S.E.	− ·007	W. by N. and E. by N.	+ ·002
W.S.W. and E.S.E.	− ·002	W.N.W. and E.N.E.	+ ·003
W. by S. and E. by S.	000	N.W. and N.E.	+ ·004
		N.W. by N. to N.E. by N.	+ ·005

* After the communication of this paper to the Royal Society, I received from Captain Crozier the results of a third experiment of the same kind, made in the Terror on the 20th of October 1840 in the river Derwent in Van Diemen Island. I subjoin these results in further evidence of the general correctness of the deductions which have been drawn in regard to the influence of the ship's iron on the intensity observations made at sea.

Ship's head.	Correction.	Ship's head.	Correction.
E.	+ ·001	W.	+ ·003
E.S.E.	− ·001	W.N.W.	000
S.E.	− ·005	N.W.	+ ·007
S.S.E.	− ·008	N.N.W.	+ ·005
S.	− ·008	N.	+ ·004
S.S.W.	− ·007	N.N.E.	+ ·005
S.W.	− ·005	N.E.	+ ·008
W.S.W.	+ ·001	E.N.E.	+ ·002

Table III.

Abstract of the Intensities observed in Her Majesty's Ship Erebus, in the space of the Atlantic comprised within the isodynamic curve of 0·9.

Position. Lat.	Position. Long. E.	Intensity.	Ship's head.	Correction for ship's head.	Corrected intensity. London = 1·372.	Position. Lat.	Position. Long. E.	Intensity.	Ship's head.	Correction for ship's head.	Corrected intensity. London = 1·372.
° ′	° ′					° ′	° ′				
− 4 49	327 43	·921	S.S.W	−·008	·913	−15 30	348 51	·810	E.	+·001	·811
− 6 24	327 24	·897	S.	−·008	·889	−14 33	349 37	·816	N.E. by E. / S.W. by S.	−·001	·815
− 7 50	327 28	·888	S.	−·008	·880						
− 9 21	327 58	·870	S.S.E.	−·008	·862	−13 37	350 33	·822	S.S.W. / E. by N.	−·005	·817
−11 03	328 22	·856	S.S.E.	−·008	·848						
−12 32	328 57	·840	S.E. by S.	−·008	·832	−14 19	350 33	·813	E. ¼ N.	+·002	·815
−14 0	329 28	·822	S.S.E.	−·008	·814	−14 51	350 31	·815	E. W. / N. N.W.	+·003	·818
−15 04	330 06	·822	S.S.E.	−·008	·814						
−16 52	330 27	·818	S. by E.	−·008	·810	−14 08	351 31	·825	S.W. / N.E.	−·002	·823
−19 01	330 45	·814	S. ½ E.	−·008	·806						
−21 31	330 47	·818	S.	−·008	·810	−13 43	352 01	·823	S. by W. ½ W.	−·008	·815
−21 47	330 50	·819	S.	−·008	·811	−14 26	351 57	·825	S.	−·008	·817
						−15 04	351 54	·825		−·008	·817
−23 14	330 55	·823	S. ½ W. / S.E.	−·008	·815	−15 23	352 06	·819	S. by W.	−·008	·811
−24 22	331 51	·829	S.E. by S. / S.S.E.	−·008	·821	−15 17	352 35	·820	S.	−·008	·812
						−15 19	353 13	·820	E.N.E.	+·003	·823
−25 40	332 46	·828	S.E. by E.	−·005	·823	−15 07	353 44	·829	S.S.W.	−·008	·821
						−15 05	354 08	·825	S. by W.	−·008	·817
−26 50	333 30	·839	S.S.E. / N. by E.	−·004	·835	−17 26	353 28	·823	S.W.	−·007	·816
−26 12	333 22	·833	S.E.	−·007	·826	−18 53	352 45	·827	S.S.W.	−·008	·819
−27 04	334 13	·836	S.E. by E.	−·005	·831	−20 51	351 55	·823		−·008	·815
						−22 02	351 27	·821	S. by E.	−·008	·813
−27 43	335 06	·845	S. by E. / N.N.E ½ E.	−·002	·843	−22 21	351 22	·818	S. by W.	−·008	·810
−26 53	335 26	·840	N.N.E. / S.S.E.	−·002	·838	−23 35	351 05	·821	W. / S.S.W.	−·002	·819
−26 01	335 20	·833	N. by E. / N.E. by N.	+·005	·838	−23 47	350 29	·818	W. / E.	+·001	·819
−25 21	335 28	·826	S.E.	−·007	·819	−24 34	348 39	·818	W.	+·001	·819
−26 12	336 12	·829	S.E. by E.	−·005	·824						
−27 04	337 25	·832	S.E.	−·007	·825	−24 46	348 12	·820	W. / S.W.	−·001	·819
−27 43	338 37	·833	E.S.E.	−·002	·831	−25 19	347 54	·820		−·007	·813
−28 19	340 10	·828	E. by S.	000	·828	−25 31	347 45	·829	S.W.	−·007	·822
−28 01	341 45	·828	E.N.E.	+·003	·831						
−27 26	342 29	·830	N.E. by E.	+·003	·833	−26 08	347 03	·826	W. E. / S. by E.	−·002	·824
−26 47	342 57	·824	N.E. by N.	+·005	·829	−27 03	346 32	·844	S.S.W.	−·008	·836
−25 34	342 58	·823	N.N.E.	+·005	·828	−27 56	346 44	·834		−·007	·827
−24 10	343 04	·812	N.N.E.	+·005	·817	−29 02	348 46	·836	S.E.	−·007	·829
						−30 14	351 37	·852		−·007	·845
−22 40	343 42	·811	N.E. / N.E. ½ E.	+·004	·815	−31 08	353 56	·849	S.E. ½ E.	−·006	·843
−21 30	344 17	·810		+·003	·813	−31 46	356 38	·872	S.E. by E.	−·006	·866
−20 20	345 12	·810		+·003	·813	−31 13	358 38	·872	E. by S.	000	·872
−18 53	345 46	·817	N.E. by E.	+·003	·820						
−17 30	346 15	·820		+·003	·823	−30 20	359 50	·878	E. / S.E. / S.W.	−·005	·873
−17 11	346 40	·817		+·003	·820						
−16 30	347 17	·816	N.E.	+·004	·820						
−15 15	348 01	·821	N.E. by E. ½ E.	+·003	·824	−31 13	359 39	·882	S.E. / S.W.	−·007	·875
−15 20	348 07	·813									
						−32 01	2 17	·886		−·007	·879
−15 49	348 09	·815	S.S.W. / E. by N. ½ N.	−·003	·812	−32 54	4 53	·914	S.E.	−·007	·907

When these results are transferred to the map of the portion of the Atlantic to which they refer, and are examined in detail, their systematic character becomes much more obvious than in the Table, where, in consequence of the successive alternations of increasing and decreasing latitude, their consistency is not so easily followed by the eye. On attentive examination of the map it is not difficult to trace within small limits the course of an ideal line, which should connect the points in the several meridians, where the intensity was weakest at the epoch of Captain Ross's voyage. The determination of the position of this line is easier, and in some respects more sure, than that of an isodynamic line, because it is independent of the permanency of the magnetism of the needle employed, for more than the few days occupied in the immediate research; and it is also independent of the correctness of an assumed intensity at a base station. It is therefore to be expected that the position of this line will become in future years the subject of frequent examination, serving to mark, from time to time, the progress of the secular change in its position. This may be done with the more interest and advantage, because there is reason to believe that its position is changing rapidly in the space referred to, particularly in the eastern meridians; and that the southern magnetic hemisphere, in so far as its boundary may be indicated by this line, is in that quarter of the globe gaining rapidly upon the northern. In the first of the present series of "Contributions"*, the line of least intensity was drawn from observations corresponding nearly to the epoch of 1825, and this line of 1825 is lightly retraced in the present map for the purpose of comparison. It will be seen, that whilst its general direction is consistent with the observations of Captain Ross in 1840, its earlier position is everywhere three or four degrees south of that which would be now inferred. It is readily admitted that many of the observations from which the line of 1825 was drawn are inferior in precision to those of Captain Ross; and I rejoice in the late improvement in this class of observations, for which we are mainly indebted to the method and instrument devised by Mr. Fox, and to the zeal and unwearied patience of our naval officers. To an observer, however, who is proceeding in a nearly north and south direction, very little uncertainty attends the determination of the time and place at which he finds the weakest intensity; and if we compare the observations of Dunlop, Erman, and Sulivan, with those of Ross and Crozier, we invariably find that the earlier observer makes the place of the minimum a little more southerly than later determinations.

A glance at the map suffices to show where determinations are now most wanted, and to point out the track where additional observations would be most valuable: it would be nearly that of a vessel making the eastern passage to the Cape of Good Hope.

* Philosophical Transactions, 1840, Plate V.

§ 6. *Observations of Intensity between the Cape of Good Hope and Kerguelen Island.*

On the 6th of April 1840 the Expedition quitted Simon's Bay, and on the same night the Erebus and Terror parted company, and made their passage to Kerguelen Island on separate courses. Although the weather was very unfavourable, the practice of daily observation with the magnetical instruments was continued with very few exceptions, by the Erebus during the whole passage, and by the Terror from Simon's Bay as far as the meridian of the Crozet Islands, which was the first rendezvous. The observations of intensity on board the Erebus were chiefly made with deflector S, the other deflector N having been used only five times during the whole passage, whilst the number of observations with S amounts to thirty-six. For the values of w', in the case of deflector S, we have the comparisons with the constant weights at the Cape and Kerguelen Island, and three good intermediate comparisons at sea, viz. on the 11th, 12th, and 18th of April; a fourth attempt on the 1st of May failed from some accidental error in the observation with the constant weight. Pursuing the plan of graphical representation already described, we find that the line connecting the terminations of the ordinates at the Cape and at Kerguelen Island passes either through or extremely near the terminations of the other three ordinates, indicating the unchanged magnetism of the deflector; and we obtain the following Table of the values of w' for the degrees of deflection in the Table:

Values of w', deflector S, Erebus; Cape of Good Hope to Kerguelen Island.

°	grs.	°	grs.
25	= 2·628	31	= 2·426
26	= 2·594	32	= 2·392
27	= 2·560	33	= 2·358
28	= 2·527	34	= 2·324
29	= 2·494	35	= 2·291
30	= 2·460	36	= 2·260

Regarding the Cape as the primary station, and its intensity = 0·715 (London = 1), the intensity at the other stations is given by the formula

$$I' = \cdot 1837\ w' \operatorname{cosec} v'.$$

The observations with deflector N between the Cape and Kerguelen Island being few, and the two intermediate comparisons at sea with the constant weights exhibiting considerable discordances, either from the unfavourable circumstances of weather, or possibly in consequence of an actual small change of force in the deflector, I have not attempted to deduce results from the observations either with deflector N, or with N and S combined. I have also omitted in the mean deductions the results of the observations with the constant weight of one grain on the 1st of May and 29th of June, these observations being obviously affected with some accidental error.

For the Terror's deflectors we have only the comparisons with the constant weights at the Cape and Kerguelen Island from which to derive the values of w' for the intermediate degrees of v'. Connecting the values of w' obtained by those comparisons

for deflector N, with those in the former table for the same deflector, and presuming that the values corresponding to the intermediate degrees change in a nearly uniform progression, we derive the following Table for the degrees of v' observed between the Cape and Kerguelen Island:—

Values of w', deflector N, Terror; Cape of Good Hope to Kerguelen Island.

°	gr.	°	gr.
26	= ·917	33	= ·873
27	= ·911	34	= ·866
28	= ·906	35	= ·859
29	= ·900	36	= ·852
30	= ·894	37	= ·845
31	= ·887	38	= ·837
32	= ·880	39	= ·828

The Cape being the primary station, and its intensity = 0·715, we obtain the intensities at the other stations by the formula

$$I' = \cdot 529\ w' \operatorname{cosec} v'.$$

In the case of deflector S, the values of w' which result from the comparisons with the constant weights at the Cape and Kerguelen Island are so nearly the same (·733 at the Cape, and ·735 at Kerguelen Island), that we may take the arithmetical mean ·734 for all the intermediate stations without sensible inconvenience; whence the formula for the calculation of the intensity becomes

$$I' = \cdot 388 \operatorname{cosec} v'.$$

As we have only the comparisons with the constant weights at the Cape and Kerguelen Island from which to derive the values of w' for the Terror's deflectors for all the intermediate degrees of v', we might be disposed to fear that the data were scarcely sufficient for that purpose; but when we examine the intensities deduced from the observations with the two deflectors (both having been used at all the intermediate stations except one), we perceive that their accordance is in general remarkably good, which would scarcely be the case unless the elements of calculation were tolerably correct. So close an agreement in the partial observations, in a passage made in tempestuous weather, is certainly very creditable both to the instrument and to the observers.

Those who interest themselves in examining the progress which magnetic maps of the portion of the globe occupied by sea are making towards accuracy, will compare the intensities between the Cape of Good Hope and Kerguelen Island, contained in the subjoined Tables, with the isodynamic lines drawn from Mr. Dunlop's observations in the first Number of these Contributions*. The prolongation of those lines into the more southerly latitudes traversed by the Erebus and Terror would suit extremely well with the intensities which are here given.

* Philosophical Transactions, 1840, Plate V.

Table IV.

Observations of the Magnetic Intensity on Shore and on Board Her Majesty's Ship Erebus, with Needle F 1, between the Cape of Good Hope and Kerguelen Island.

1840.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.	Intensity. = 1·372.
	° ′	° ′	h m		° ′	°			
April 3.	−34 11	18 26		S.	35 35	72	W.	·717	·984
7.	−35 14	18 27	11 40 A.M.	S.	35 23	71·5	S. by E.	·723	·992
8.	−35 48	18 47	10 A.M.	S.	35 11·1	70	E.S.E.	·728	·999
			10 45	S.	35 12	70	W. by S.	·728	
9.	−36 4	19 19	10 A.M.	S.	35 29·3	66·5		·720	·988
10.	−36 11	20 42	9 40 A.M.	S.	35 0·7	66·5	S.E. by S.	·733	1·005
11.			10 15 A.M.	S.	34 36·2	66·5		·745	
			10 40 A.M.	S. and N.	49 24·4	66·5			
			11 0 A.M.	N.	28 54·5	66·5		·742	1·018
			11 30 A.M.	weight 1 grain.	14 16·2	71		·744	
11.	−36 35	21 20	Noon.	weight 1½ grain.	22 10·2	71	S.	·731	
			0 30 P.M.	weight 2 grains.	29 40·0	71		·750	
12.	−37 19	21 37	10 30 A.M.	S.	33 48·8	72·5		·769	
			11 A.M.	S.	33 21	72·5		·784	
			11 40	weight 1 grain.	13 54·2	72·5		·763	·770 1·057
12.	−37 20	21 37	2 15 P.M.	S.	33 53·1	72		·766	
13.	−38 13	21 30	10 40 A.M.	S.	34 0·7		W.S.W.	·763	1·047
14.	−40 5	20 38		S.	34 25·5	62	S.S.E.	·750	1·029
15.	−40 29	22 22	11 30 A.M.	S.	33 5·5	68·5	S.E. by S.	·792	1·087
16.	−41 24	25 0	9 30 A.M.	S.	33 29·1	56	S.E. by S.	·780	1·071
			10 10 A.M.	S. and N.	47 59·5	56			
			10 50 A.M.	N.	27 32·5	56			
17.	−41 58	26 38	9 20 A.M.	S.	32 52·7	61·5	S.S.E.	·799	1·096
18.	−43 7	28 43	10 A.M.	S.	32 33·2	60	S.S.E.	·810	
			10 30 A.M.	S. and N.	47 9	60			
			10 40 A.M.	N.	26 48	60		·832	1·142
			11 0 A.M.	weight 1 grain.	12 44·3	59		·830	
			11 20 A.M.	weight 1½ grain.	18? 6·5*	59		·841	
			11 45 A.M.	weight 2 grains.	25 53·3	59		·849	
19.	−44 19	31 6	11 30 A.M.	S.	31 58·6	59	S.S.E.	·830	1·139
20.	−45 44	34 16	11 15 A.M.	S.	31 11	48·5		·859	1·179
21.	−47 00	37 14		S.	30 56·2	45	S.E. by E.	·868	1·191
22.	−47 00	38 48	6 30 A.M.	S.	31 15·6	44		·856	1·175
23.	−46 46	42 41	9 45 A.M.	S.	30 3·4			·902	1·237
24.	−47 1	46 10		S.	29 23	45	S.E. ½ E.	·929	1·275
26.	−46 41	50 52	11 20 A.M.	S.	29 10·7	44	S.E. by S.	·937	1·285
28.	−46 28	52 43	Noon.	S.	29 6·2	44	W.S.W.	·941	1·290
29.	−46 29	52 26	1 30 P.M.	S.	28 36·7	43	S.W. by W.	·962	1·319
30.	−46 18	52 4	11 30 A.M.	S.	28 20·5		S.S.W.	·974	1·336
May 1.	−46 25	52 1	10 30 A.M.	S.	28 25	45	S. by E. ½ E.	·970	1·331
			11 0 A.M.	S. and N.	42 36·2				
			11 30 A.M.	N.	21 49				
			Noon.	weight 1 grain.	11 13·3			·939†	
2.	−46 57	55 39	10 15 A.M.	S.	28 23	47	S.E.	·972	1·333
3.	−47 19	59 10	10 30 A.M.	S.	27 33·5	40		1·009	1·384
			10 50 A.M.	S. and N.	42 0·5				
			11 10 A.M.	N.	21 36				
4.	−47 41	62 59	9 40 A.M.	S.	26 22·5	43		1·068	1·466
7.	−48 36	69 21	Noon.	S.	26 7·5		N.N.W.	1·082	1·485
8.	−48 36	69 7		S.	25 54·7	39	S.W. by S.	1·091	1·497
11.	−48 30	69 52	9 30 A.M.	S.	25 49·5		S.W. by W. ½ W.	1·095	1·502
12.	−48 39	68 57	11 30 A.M.	S.	26 19·2		N.	1·070	1·085 1·488
			0 30 P.M.	S.	25 45·5		S.W. by W. ½ W.	1·100	

* 18° is probably an error of transcription, and should be 19°; the result of 18° 06′·5 would be ·885; that of 19° 06′·5 is ·841, as entered in the Table.

† Omitted in the mean.

Table IV. (Continued.)

1840.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.		Intensity. = 1·372.
			h		° ′	°				
May 18.	Christmas Harbour.		11 A.M.	S.	26 19·7	39	N.W.	1·069		1·467
June 26.	−48 41	68 54	Noon.	S.	26 21·3	34·5		1·068		
			to	S. and N.	40 42·7					
			4 P.M.	N.	20 6·3		Observed			
29.			10 A.M. to	weight 1 grain.	10 24·1		on shore.	1·010*	1·068	1·465
			2 P.M.	weight 1½ grain.	14 48·6			1·063		
				weight 2 grains.	20 19·6			1·073		
July 7.	Moored in Christmas Harbour.			S.	26 28·1		N.E.	1·062		
				S.	26 21·8		E.	1·068		
				S.	26 5·2		S.E.	1·083	1·076	
				S.	25 54·2		S.	1·092		
				S.	25 56·4		S.W.	1·090		
9.				S.	26 19·8	41	N.	1·069		
				S.	26 11·1		N.W.	1·076		
				S.	26 19·9		W.	1·070		

Table V.

Observations of the Magnetic Intensity on Shore and on Board Her Majesty's Ship Terror, with a four-inch Fox's Needle, between the Cape of Good Hope and Kerguelen Island.

1840.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.		Intensity. = 1·372.
			h m		° ′	°				
March 18.	Simon's Bay.		7 A.M.	N.	38 44·1		N.W.	·702		
	−34 11	18 26		N.	38 35·8		W.N.W.	·705		
			8 A.M.	N.	38 39		W.	·704		
				N.	38 04·4		W.S.W.	·718		
			6 P.M.	N.	38 43·7		N.	·702		
				N.	38 32·6		N.N.W.	·706		
			6 30 P.M.	N.	38 46·3		N.N.E.	·702		
				N.	38 23·5		N.E.	·710		
19.			9 A.M.	N.	38 13·7		E.N.E.	·713	·712	·977
				N.	38 22·9		E.	·710		
			9 30 A.M.	N.	38 26·0		E.S.E.	·709		
				N.	38 02·1		S.E.	·718		
			10 0 A.M.	N.	38 04·3		S.S.E.	·718		
				N.	37 40·8		S.	·729		
			11 0 A.M.	N.	37 43·2		S.S.W.	·728		
				N.	37 58·5		S.W.	·720		
21.			Noon.	N.	38 07·1			·715		
23.			11 30 A.M.	N.	38 16·2					
21.				S.	32 59·3			·715		
23.				S.	32 43·8		Observed		·715	·981
21.				weight ·5 grain.	21 46·1		on shore.	·715		
23.				weight ·5 grain.	21 47·9					
21.				weight ·3 grain.	12 38·2			·715		
23.				weight ·3 grain.	12 56·5					

* Omitted in the mean.

TABLE V. (Continued.)

1840.	Position. Lat.	Position. Long. E.	Time of day.	Method employed.	Deflection observed.	Thermometer.	Ship's head.	Intensity. London = 1·000.		= 1·372.
	° ′	° ′			° ′					
April 8.	−36 16	20 04	3 50 P.M.	N.	37 31·7	70	S. by E.	·730	·731	1·003
				S.	32 00·2	70		·733		
10.	−36 52	18 25	9 20 A.M.	N.	37 53·1	66	W. ½ N.	·722	·724	·994
				S.	32 21·1	66		·726		
11.	−37 16	17 24	5 15 P.M.	N.	38 6	66	W.S.W.	·717	·722	·991
				S.	32 15·6	66		·728		
12.	−37 44	16 36	11 40 A.M.	N.	37 56·7	72	S.W.	·720	·721	·990
				S.	32 31·6			·722		
13.	−38 47	17 00	9 10 A.M.	N.	37 20·2	70		·735	·734	1·007
				S.	31 59·9	70		·733		
14.	−38 58	17 26	9 05 A.M.	N.	36 47·8	62	S.	·748	·750	1·028
				S.	31 07·4	62		·752		
15.	−40 45	19 20	3 50 P.M.	N.	36 49·4	68		·747	·760	1·044
				S.	30 09·7	68		·773		
16.	−42 40	22 02	3 45 P.M.	N.	35 37·7	56	S.E. by E.	·776	·775	1·063
				S.	30 11	56		·773		
17.	−42 56	23 12	9 30 A.M.	N.	35 21·7	61		·782	·788	1·081
				S.	29 15·3	61	S.	·795		
18.	−44 28	24 55	9 20 A.M.	N.	34 28·5	60		·807	·805	1·104
				S.	28 56·4	60		·803		
19.	−46 0	26 12	1 P.M.	N.	33 48·0	59	S.S.E.	·828		1·136
20.	−46 41	29 0	9 20 A.M.	N.	33 56·0	48	S.E. by E.	·821	·822	1·127
				S.	28 13·1	48		·822		
23.	−46 45	40 05	9 40 A.M.	N.	32 12·1	44		·873	·866	1·189
				S.	26 52·8	44		·859		
24.	−47 0	43 48	9 30 A.M.	N.	31 28·7	45	S.E. ½ E.	·896	·901	1·236
				S.	25 24·7	45		·905		
25.	−47 50	45 20	2 40 P.M.	N.	30 37·7	44		·924	·924	1·268
				S.	24 52·1	44		·924		
July 3.	Christmas Harbour, Kerguelen Island.		10 A.M.	N.	27 03·1	36		1·0675		
4.			2 P.M.	N.	26 41	36				
3.			A.M.	S.	21 31·3	36		1·0675		
4.			P.M.	S.	21 14·0	36	Observed on shore.		1·0675	1·465
3.	−48 41	68 54	A.M.	weight ·5 grain.	14 18·5	36		1·070		
4.			P.M.	weight ·5 grain.	14 13·7	36				
3.			A.M.	weight ·3 grain.	8 29·7	36		1·065		
4.			P.M.	weight ·3 grain.	8 29·5	36				
7.	−48 41	68 54	Noon.	N.	26 37·1	38	N.	1·079		
				N.	26 41·4	38	N.E.	1·076		
			1 0 P.M.	N.	26 26·2	38	E.	1·087		
				N.	26 29·8	38	S.E.	1·084	1·084	
			1 30 P.M.	N.	25 54·7	38	S.	1·111		
				N.	26 32·1	38	S.W.	1·083		
			2 0 P.M.	N.	26 40·3	38	W.	1·077		
				N.	26 40·8	38	N.W.	1·076		

Table VI.

Abstract of the Intensities observed in Her Majesty's Ships Erebus and Terror between the Cape of Good Hope and Kerguelen Island.

Position.		In which ship observed.	Intensity.	Ship's head when at sea.	Correction for ship's head.	Corrected intensity. London = 1·372.
Lat.	Long. E.					
−34° 11′	18° 26′	Erebus and Terror.	0·981	Observed on shore.		0·981
−37 44	16 36	Terror.	0·990	S.W.	−·007	0·983
−35 14	18 27	Erebus.	0·992	S. by E.	−·008	0·984
−36 04	19 19	Erebus.	0·988	W. by S.	·000	0·988
−37 16	17 24	Terror.	0·991	W.S.W.	−·002	0·989
−36 16	20 04	Terror.	1·003	S. by E.	−·008	0·995
−36 52	18 25	Terror.	0·994	W. ½ N.	+·002	0·996
−36 11	20 42	Erebus.	1·005	S.E. by S.	−·008	0·997
−35 48	18 47	Erebus.	0·999	E.S.E. / W. by S.	−·001	0·998
−38 47	17 00	Terror.	1·007	S.	−·008	0·999
−36 35	21 20	Erebus.	1·018		−·008	1·010
−38 58	17 26	Terror.	1·028		−·008	1·020
−40 05	20 38	Erebus.	1·029	S.S.E.	−·008	1·021
−40 45	19 20	Terror.	1·044	S.	−·008	1·036
−38 13	21 30	Erebus.	1·047	W.S.W.	−·002	1·045
−42 40	22 02	Terror.	1·063	S.E. by E.	−·005	1·058
−41 24	25 0	Erebus.	1·071	S.E. by S.	−·008	1·063
−42 56	23 12	Terror.	1·081	S.	−·008	1·073
−40 29	22 22	Erebus.	1·087	S.E. by S.	−·008	1·079
−41 58	26 38	Erebus.	1·096	S.S.E.	−·008	1·088
−44 28	24 55	Terror.	1·104	S.	−·008	1·096
−46 41	29 0	Terror.	1·127	S.E. by E.	−·005	1·122
−46 0	26 12	Terror.	1·136		−·008	1·128
−44 19	31 06	Erebus.	1·139	S.S.E.	−·008	1·131
−43 07	28 43	Erebus.	1·142		−·008	1·134
−47 00	38 48	Erebus.	1·175	S.E. by E.	−·005	1·170
−45 44	34 16	Erebus.	1·179	S.S.E.	−·008	1·171
−46 45	40 05	Terror.	1·189	S.E. ½ E.	−·006	1·183
−47 00	37 14	Erebus.	1·191	S.E. by E.	−·005	1·186
−47 0	43 48	Terror.	1·236	S.E. ½ E.	−·006	1·230
−46 46	42 41	Erebus.	1·237	S.E. by E.	−·005	1·232
−47 50	45 20	Terror.	1·268	S.E. ½ S.	−·007	1·261
−47 01	46 10	Erebus.	1·275	S.E. ½ E.	−·006	1·269
−46 41	50 52	Erebus.	1·285	S.E. by S.	−·008	1·277
−46 28	52 43	Erebus.	1·290	W.S.W.	−·002	1·288
−46 29	52 26	Erebus.	1·319	S.W. by W.	−·005	1·314
−46 25	52 01	Erebus.	1·331	S. by E. ½ E.	−·008	1·323
−46 57	55 39	Erebus.	1·333	S.E.	−·007	1·326
−46 18	52 04	Erebus.	1·336	S.S.W.	−·008	1·328
−47 19	59 10	Erebus.	1·384	S.E.	−·007	1·377
−47 41	62 59	Erebus.	1·466		−·007	1·459
−48 41	68 54	Erebus and Terror.	1·465	Observed on shore.		1·465
−48 41	68 54	Erebus.	1·467	N.W.	+·004	1·471
−48 39	68 57	Erebus.	1·488	N. / S.W. by W. ½ W.	000	1·488
−48 36	69 07	Erebus.	1·497	S.W. by S.	−·008	1·489
−48 36	69 21	Erebus.	1·485	N.N.W.	+·005	1·490
−48 30	69 52	Erebus.	1·502	S.W. by W. ½ W.	−·005	1·497

III. *Researches in Physical Geology.—Third Series.* *By* W. HOPKINS, *Esq.*, *M.A.*, *F.R.S.*, *Fellow of the Royal Astronomical Society, of the Geological Society, and of the Cambridge Philosophical Society.*

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On the Thickness and Constitution of the Earth's Crust.

1. THE result at which I arrived in my preceding memoir, respecting the precessional motion of the pole, on the hypothesis of the earth's interior fluidity, is the following:

$$P' - P_1 = \left(1 - \frac{\varepsilon}{\varepsilon_1}\right)\left(1 - \frac{\eta}{1 + \frac{h}{q^5 - 1}}\right) P_1, \quad \ldots\ldots\ldots \quad (1.)$$

where P_1 denotes the precession of a solid homogeneous spheroid of which the ellipticity $= \varepsilon_1$, that of the earth's exterior surface, and P' the precession of the earth, supposing it to consist of an interior heterogeneous fluid, contained in a heterogeneous spheroidal shell, of which the interior and exterior ellipticities are respectively ε and ε_1, the transition being immediate from the entire solidity of the shell to the perfect fluidity of the interior mass.

2. In the application of this result to the actual case of the earth, we must observe, in the first place, that, supposing the interior mass to be fluid, its fluidity cannot be quite *perfect*, as explained in the introductory observations to my first memoir. Consequently the assumption, made in our investigations, of the absence of all tangential action between the shell and fluid will not be accurately true. Moreover, it would seem extremely probable that the transition from the solidity of the shell to the fluidity of the interior mass, instead of being immediate, must be gradual. If, however, the thickness of the shell be not considerable with reference to the earth's radius, the fluidity of the portion not remote from the centre will be nearly perfect, and the whole of the interior mass, with the exception of that part near the actual solid portion, may, as a near approximation, be considered as perfectly fluid with reference to any mechanical action upon it. Again, supposing the change from the solidity of the exterior to the fluidity of the interior mass to be continuous, let us conceive a surface passing through all the lowest points of that portion of the mass which may be regarded as perfectly solid, and another surface through all the highest points of that portion which may be regarded as perfectly fluid. The first of these surfaces will be one of equal solidity and the second one of equal fluidity; the fluidity of the mass contained between them being imperfect. Now if we were to consider

the whole of this imperfectly fluid mass as entirely solid, we should manifestly take the thickness of the shell too large to represent the actual phenomena depending on that thickness; and if, on the contrary, we should consider the whole of the imperfectly fluid portion as perfectly fluid, we should take the thickness of the shell too small. Hence there must be some surface of equal fluidity (or, if we please so to term it, of equal *solidity*) intermediate to the above surfaces, such that if the whole mass superior to it were entirely solid, and that inferior to it entirely fluid, the phenomena of precession and nutation would be the same as in the actual case of a gradual transition from the solidity of the superior to the fluidity of the inferior portions of the mass. When, therefore, we speak of the interior surface of the solid shell with reference to our previous investigations as applicable to the case of the earth, it is this intermediate, or *effective surface*, which is always to be understood; and the thickness of the earth's crust, as defined by this surface, I shall term its *effective thickness*.

3. In order that the value of P′ may agree with that determined by observation, we must have approximately

$$P' - P_1 = \frac{1}{8} P_1,$$

and, therefore, referring to the equation of Article 1, we must have

$$\left(1 - \frac{\epsilon}{\epsilon_1}\right)\left(1 - \frac{\eta}{1 + \frac{k}{q^5 - 1}}\right) = \frac{1}{8}. \quad \ldots\ldots\ldots \quad (2.)$$

An approximate value of $\frac{k}{q^5 - 1}$ will be obtained by making ϱ constant in the expression given for it in Article 5, Mem. II. We then have

$$\frac{k}{q^5 - 1} = \frac{2 a^5}{a_1^5 - a^5},$$

$$= \frac{2}{q^5 - 1}, \qquad \left(q^5 = \frac{a_1}{a}\right);$$

which gives

$$\left(1 - \frac{\epsilon}{\epsilon_1}\right)\left(1 - \eta \cdot \frac{q^5 - 1}{q^5 + 1}\right) = \frac{1}{8}.$$

It has been stated (Art. 2. Mem. II.), that if η be ever negative, it can only be so when $a = a_1$ very nearly. But in this case $q^5 - 1$ is extremely small, and therefore the value of the second factor on the left-hand side of the above equation will be very nearly = unity. In all other cases it will be less than unity. Let it $= 1 - \beta$; then

$$1 - \frac{\epsilon}{\epsilon_1} = \frac{1}{8} \cdot \frac{1}{1 - \beta},$$

and

$$\frac{\epsilon}{\epsilon_1} = 1 - \frac{1}{8} \cdot \frac{1}{1 - \beta}.$$

If, as an approximation, we omit β (which will necessarily be considerably smaller

than unity for such values of $\frac{a_1}{a}$ as we shall be concerned with), we have

$$\frac{\varepsilon}{\varepsilon_1} = 1 - \frac{1}{8} = \frac{7}{8}, \quad \ldots \ldots \ldots \ldots \quad (3.)$$

which gives *too great* a value of ε. Now, that we may be able to satisfy equation (2.), ε must be less than ε_1, *i. e.* it must diminish as the thickness of the earth's crust increases; and, therefore, the thickness which corresponds to this approximate value of ε will be *too small*; or the actual thickness of the solid crust of the globe which would give the precession P, must necessarily be *greater* than that for which the value of ε is $\frac{7}{8}\varepsilon_1$.

4. We must now proceed to determine the relation between the value of $\frac{\varepsilon}{\varepsilon_1}$ and that of $a_1 - a$, the thickness of the solid crust.

If we assume (as I shall now do) that the fusibility of the matter composing the earth is equal at equal depths*, it would seem that the only conceivable causes which can affect the degree of solidity or fluidity of the mass, are *temperature* and *pressure*. It may be doubted by some persons whether solidification be actually promoted by the latter cause or not; but there will be no corresponding uncertainty in our conclusions respecting the minimum thickness of the earth's crust consistent with the observed amount of precession; because, if they be true, this cause being effective, they will easily be seen to be so, *à fortiori*, if it produce no effect.

If temperature produced no effect in solidification, the surfaces of equal solidity (or fluidity) would be surfaces of equal pressure, and therefore of equal density; and if pressure did not promote solidification, the surfaces of equal solidity would be isothermal surfaces. Assuming both causes to be effective, conceive two surfaces of equal density and temperature respectively, passing through the same point (in the axis of the spheroid, for instance); then will the surface of equal solidity through the same point be intermediate to the two former, the ellipticities of which will therefore be *limits* to that of the surface of equal solidity. It is these limits which we must now proceed to determine.

The greatest difficulty in the determination of the temperature at any point of a body cooling by conduction, is that which arises from satisfying the conditions at the surface in each particular case. This has been effected only in the sphere, the circular cylinder, and a few other simple cases, but not including that of the spheroid, the *isothermal surfaces* of which, consequently, have never been completely determined†.

* This may admit of local exceptions, such as probably exist, without any sensible modifications in our general conclusions.

† An ingenious memoir on this subject by M. Lamé is contained in the fifth volume of the 'Mémoires des Savans Etrangers,' in which he has examined the conditions under which the isothermal surfaces within an ellipsoid will also be ellipsoids, when it has arrived at a permanent state of temperature. He has also made the general expression for the temperature at any time to depend on the integration of certain differential equa-

The approximate solution which I am about to offer is founded on the following assumption. Let r' be the distance of any point on the surface of the spheroid from the centre, and a_1 the polar or least distance; it is assumed that the temperature in the spheroid at a depth $= r' - a_1$ is the same as it would have been at that depth if the spheroid had been a sphere with radius $= r'$. If the ellipticity be small, and the process of cooling has been continued a sufficient length of time, this assumption will manifestly be almost accurately true. The solution of the problem is thus made to depend on formulæ which have been given by Poisson in his *Théorie de la Chaleur*. To this I now proceed.

§. *Determination of the Forms of Isothermal Surfaces within the Earth.*

5. Adopting Poisson's notation*, let u denote, at any time t, the temperature of any point of the earth, and let

$$u = u_1 + u',$$

where u_1 is such as to satisfy the general differential equation for the propagation of heat by conduction, the conditions relative to the original temperature, and that which would exist at the surface at any time if the earth were a sphere whose radius $= a_1$. Then when t becomes very great, as it is assumed to be in the case of the earth, taking the common expression for the temperature in a sphere of large radius, as a sufficient approximation to that of the actual case of the earth, we have

$$u_1 = \mathrm{C}\frac{a_1}{\pi r}\left(\sin\frac{r}{a_1}\pi - \frac{\pi r}{b\,a_1^3}\cos\frac{\pi r}{a_1}\right)\varepsilon^{-\frac{\kappa^2\pi^2}{a_1^2}t},$$

where C is the value of u_1 at the centre†. At the surface the first term vanishes, and the value of u_1 is reduced to the second term, which, however, is so small that it may here be altogether neglected. Consequently

$$u_1 = \mathrm{C}\frac{a_1}{\pi r}\sin\frac{r}{a_1}\pi\,\varepsilon^{-\frac{\kappa^2\pi^2}{a_1^2}t}.$$

Let ζ denote the value of u at any point for which $r = a_1$, ζ being a function of t and of θ, the angle which r makes with the axis of revolution of the spheroid; or since (t being very large) $u_1 = 0$, approximately when $r = a_1$, ζ may be taken as the value of u' for that value of r. It remains to find a value of u' which shall satisfy the general differential equation, and the particular condition $u' = \zeta$ when $r = a_1$‡.

Let

$$r\,u' = \mathrm{U}_0 + \mathrm{U}_1 + \ldots + \mathrm{U}_n + \ldots,$$

$\mathrm{U}_0 \ldots \mathrm{U}_n \ldots$ being a series of Laplace's coefficients, and functions of the polar coordinates of the proposed point. Also let

$$\zeta = (\mathrm{Z}_0 + \mathrm{Z}_1 + \ldots + \mathrm{Z}_n + \ldots)\,\varepsilon^{-mt},$$

tions of one independent variable, and of the second order. The complicated form of these equations, however, would seem to render them at present of little avail in the solution of the problem considered in the text.

* Théorie de la Chaleur, Art. 173. † Ibid. Art. 171. ‡ Ibid. Art. 173.

a series likewise of LAPLACE's coefficients, independent of r. Then shall we have*

$$U_n = R_n Z_n \varepsilon^{-mt},$$

where $R_n = M_n r^{n+1} \int_0^{\pi} \cos\left(\frac{r\sqrt{m}}{a}\cos\omega\right) \sin^{2n+1}\omega \, . \, d\omega$, M_n being an arbitrary constant. Hence if we denote the value of the definite integral by N_n, we shall have

$$u' = \{M_0 N_0 Z_0 + \ldots + M_n N_n r^n Z_n + \ldots\} \varepsilon^{-mt}.$$

When $r = a_1$, u' must $= \zeta$; and therefore if the corresponding value of N_n be denoted by (N_n), we shall have

$$M_0 (N_0) Z_0 + \ldots + M_n (N_n) a_1^n Z_n + \ldots = Z_0 + \ldots + Z_n + \ldots,$$

which gives for the determination of M_n,

$$M_n = \frac{1}{a_1^n (N_n)};$$

whence

$$u' = \left\{\frac{N_0}{(N_0)} Z_0 + \ldots + \frac{N_n}{(N_n)} \cdot \frac{r^n}{a_1^n} Z_n + \ldots\right\} \varepsilon^{-mt}.$$

According to our assumptions for the value of ζ (Art. 4.), we must have ζ equal to the temperature (u_1) in a sphere, whose radius $= r'$, at a distance $r' - a_1$ from its surface. Therefore†

$$\zeta = C \cdot \frac{1}{b r'} \left\{1 + b (r' - a_1)\right\} \varepsilon^{-\frac{a^2 \omega^2}{r'^2} t};$$

or omitting $\frac{1}{b r'}$,

$$\zeta = C \frac{r' - a_1}{r'} \varepsilon^{-\frac{a^2 \omega^2}{r'^2} t},$$

C being the temperature at the centre. Or since

$$r' = a_1 (1 + \varepsilon_1 \cos^2\theta),$$

$$\zeta = C \varepsilon_1 \cos^2\theta \, \varepsilon^{-\frac{a^2 \omega^2}{a_1^2} t},$$

omitting smaller terms.

It is here supposed that the temperature of the surface of the earth is constant and equal to zero. If we take into account the variation of external temperature in passing from the pole to the equator, we have only to consider ε_1 as the ellipticity of that surface of equal temperature which touches the earth's surface at the equator, the temperature there being also assumed as zero. Then ε_1 will be rather greater than the ellipticity of the earth.

Putting the expression for ζ under the form of LAPLACE's coefficients, we have

$$\zeta = C \varepsilon_1 \left\{\frac{1}{3} + \left(\cos^2\theta - \frac{1}{3}\right)\right\} \varepsilon^{-\frac{a^2 \omega^2}{a_1^2} t},$$

$$= \left\{\frac{C \varepsilon_1}{3} + C \varepsilon_1 \left(\cos^2\theta - \frac{1}{3}\right)\right\} \varepsilon^{-\frac{a^2 \omega^2}{a_1^2} t},$$

* Théorie de la Chaleur, Art. 173. † Ibid. Art. 171.

which gives $Z_n = 0$, except for $n = 0$, or $n = 2$; and

$$Z_0 = \frac{C\varepsilon_1}{3}, \quad Z_2 = C\varepsilon_1\left(\cos^2\theta - \frac{1}{3}\right);$$

also

$$m = \frac{a^2\pi^2}{a_1^2}.$$

Hence

$$u^1 = C\varepsilon_1\left\{\frac{1}{3}\left(\frac{N_0}{(N_0)} - \frac{N_2}{(N_2)}\cdot\frac{r^2}{a_1^2}\right) + \frac{N_2}{(N_2)}\cdot\frac{r^2}{a_1^2}\cos^2\theta\right\}\varepsilon^{-\frac{a^2\pi^2}{a_1^2}t}.$$

It remains to determine N_0, (N_0), N_2, and (N_2). We have

$$N_n = \int_0^\pi \cos\left(\frac{r}{a_1}\pi\cos\omega\right)\sin^{2n+1}\omega\, d\omega;$$

or putting $\cos\omega = x$,

$$N_n = \int_{-1}^{+1}\cos\left(\frac{r}{a_1}\pi . x\right)(1-x^2)^n\, dx;$$

and performing the integrations for $n = 0$ and $n = 2$, we obtain

$$N_0 = \frac{2}{\pi}\cdot\frac{a_1}{r}\sin\frac{r}{a_1}\pi,$$

$$N_2 = \left(\frac{48}{\pi^5}\cdot\frac{a_1^5}{r^5} - \frac{16}{\pi^3}\cdot\frac{a_1^3}{r^3}\right)\sin\frac{r}{a_1}\pi - \frac{48}{\pi^4}\cdot\frac{a_1^4}{r^4}\cos\frac{r}{a_1}\pi;$$

and putting $r = a_1$, we have

$$(N_0) = 2,$$

$$(N_2) = \frac{48}{\pi^4}.$$

Hence

$$\frac{N_0}{(N_0)} = \frac{1}{\pi}\cdot\frac{a_1}{r}\sin\frac{r}{a_1}\pi,$$

$$\frac{N_2}{(N_2)} = \left(\frac{1}{\pi}\cdot\frac{a_1^5}{r^5} - \frac{\pi}{3}\cdot\frac{a_1^3}{r^3}\right)\sin\frac{r}{a_1}\pi - \frac{a_1^4}{r^4}\cos\frac{r}{a_1}\pi;$$

and by substitution, we have the complete value of u^1; and for that of u we have

$$u = C\left\{\frac{a_1}{\pi r}\sin\frac{r}{a_1}\pi + \frac{\varepsilon_1}{3}\left(\frac{N_0}{(N_0)} - \frac{N_2}{(N_2)}\frac{r^2}{a_1^2}\right) + \varepsilon_1\frac{N_2}{(N_2)}\frac{r^2}{a_1^2}\cos^2\theta\right\}\varepsilon^{-\frac{a^2\pi^2}{a_1^2}t};$$

or putting

$$\frac{u\,\varepsilon^{\frac{a^2\pi^2}{a_1^2}t}}{C} = G,$$

we have for the equation to the isothermal surface, of which the temperature is u at the time t,

$$G = \frac{a_1}{\pi r}\sin\frac{r}{a}\pi + \frac{\varepsilon_1}{3}\left(\frac{N_0}{(N_0)} - \frac{N_2}{(N_2)}\frac{r^2}{a_1^2}\right) + \varepsilon_1\frac{N_2}{(N_2)}\frac{r^2}{a_1^2}\cos^2\theta.$$

Suppose

$$r = a_1 - x,$$
$$= a_1\left(1 - \frac{x}{a_1}\right),$$

where $\frac{x}{a_1}$ is small compared with unity. Then we have approximately

$$\frac{a_1}{\pi r}\sin\frac{r}{a_1}\pi = \frac{x}{a_1}\left(1 + \frac{x}{a_1}\right),$$
$$\frac{N_0}{(N_0)} = \frac{x}{a_1}\left(1 + \frac{x}{a_1}\right),$$
$$\frac{N_2}{(N_2)}\cdot\frac{r^2}{a_1^2} = 1 - \frac{\pi^2 - 9}{3}\cdot\frac{x}{a_1};$$

and therefore

$$G = \left(1 + \frac{\varepsilon_1}{3}\right)\frac{x}{a_1}\left(1 + \frac{x}{a_1}\right) - \frac{\varepsilon_1}{3}\left(1 - \frac{\pi^2 - 9}{3}\cdot\frac{x}{a_1}\right) + \varepsilon_1\left(1 - \frac{\pi^2 - 9}{3}\cdot\frac{x}{a_1}\right)\cos^2\theta.$$

We may here omit $\left(\frac{x}{a_1}\right)^2$ and the products of $\frac{x}{a_1}$ and ε_1, except in the last term, in which we may substitute for $\frac{x}{a_1}$ its approximate value, G. We have thus (putting $a_1 - r$ for x),

$$G = 1 - \frac{r}{a_1} + \left(1 - \frac{\pi^2 - 9}{3}G\right)\varepsilon_1\cos^2\theta;$$

whence

$$\frac{r}{a_1} = (1 - G)\left\{1 + \frac{1 - \frac{\pi^2 - 9}{3}G\,\varepsilon_1\cos^2\theta}{1 - G}\right\};$$

and

$$r = (1 - G)\,a_1\left[1 + \left\{1 + \left(1 - \frac{\pi^2 - 9}{3}\right)G\right\}\varepsilon_1\cos^2\theta\right],$$

the aproximate equation to the isothermal surface.

Hence it appears that the ellipticities of the isothermal surfaces within the earth are *greater* than that of the surface. Thus if $G = \frac{x}{a_1} = \frac{1}{10}$, we have

$$\text{ellipticity} = (1 + \cdot 07)\,\varepsilon_1 \text{ nearly.}$$

It will also be observed that it increases with G, i. e. with the depth. A further approximation gives a somewhat slower rate of increase, but the inference from the above formula is sufficient for our purpose.

§. *Ellipticity of any Surface of equal density within the Earth.*

6. If we assume the density of the earth (ϱ) at any distance (a) from its centre to be such that

$$\varrho = A\frac{\sin q' a}{a},$$

(A being constant), and take $q' a = 150°$, we obtain a value of ϵ_1 (the ellipticity of the surface) which coincides very nearly with its observed value, as shown in the common treatises on the figure of the earth. This expression for ϱ also gives us the ratio of the mean to the superficial density equal to 2·4225*, which agrees very nearly with the value determined by CAVENDISH. It therefore appears extremely probable that this formula represents very approximately the actual law of the earth's density.

The above expression for ϱ gives us

$$\frac{\epsilon}{\epsilon_1} = \frac{\tan q' a_1 - q' a_1}{\tan q' a - q' a} \cdot \frac{\left(1 - \frac{3}{q'^2 a^2}\right) \tan q' a + \frac{3}{q' a}}{\left(1 - \frac{3}{q'^2 a_1^2}\right) \tan q' a_1 + \frac{3}{q' a_1}}.$$

If we here substitute the above value of $q' a_1$, and put $a = \frac{3}{4} a_1$, we obtain a value of ϵ which nearly satisfies equation (3.) (Art. 1.).

If we take $q' a_1 = 160°$ we obtain the mean density more than three times the superficial density, and a value of ϵ_1 not so nearly coinciding with the observed value as in the former case. In this case the formula probably gives us a density increasing too rapidly with the depth, and therefore also a too rapid decrease of ellipticity in the surfaces of equal density. To obtain a value of ϵ, which will satisfy equation (3.), we must put a equal to about $\frac{4}{5} a_1$.

§. *Thickness of the Earth's Crust.*

7. If the surfaces of equal solidity were coincident with those of equal density, and we adopted the first value of $q' a_1$ mentioned in the preceding article, we should obtain the *effective thickness* of the crust $(= a_1 - a) = \frac{a_1}{4} = 1000$ miles; or if we adopt the other value of $q' a_1$ as less favourable to a great thickness of the crust, we shall have that thickness = 800 miles. But the surface of equal solidity through any point must be intermediate between those of equal density or pressure, and of equal temperature through the same point; and we have seen (Art. 5.) that the ellipticity of the latter increases with the distance from the external surface. Consequently the ellipticity of every surface of equal solidity must be greater than that of the corresponding surface of equal density, and, therefore, the effective thickness of the crust must be greater than that above determined, in order that it may be consistent with the observed amount of precession.

The thickness of the actually solid portion of the earth's crust will necessarily be less than what I have termed the effective thickness, but there cannot, I conceive, be any reasonable doubt that the difference between these quantities is small compared with either; for if τ_1 be the highest temperature at which any substance retains the property of solidity, and τ_2 the lowest at which it acquires that of fluidity, $\tau_2 - \tau_1$ is

* AIRY's Tracts, p. 178.

always found to be small compared with τ_1; and by analogy we conclude that such must be the case also with respect to the matter composing the earth, and under the pressure to which it is subjected at great depths. We may also remark, that the position of a surface of equal solidity or fluidity must necessarily so far incline to the corresponding surface of equal temperature as to differ materially from that of equal density, so that the real effective thickness of the crust is probably considerably greater than its inferior limit as above determined. Upon the whole, therefore, we may venture to assert that the minimum thickness of the crust of the globe which can be deemed consistent with the observed amount of precession, cannot be less than one-fourth or one-fifth of the earth's radius.

§. *Constitution of the Earth's Crust.*

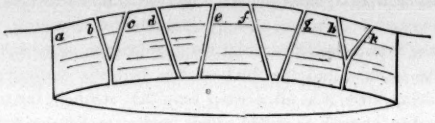
8. The results at which we have arrived respecting the thickness of the solid crust of the globe, have an important bearing on our physical theories of volcanic forces, and the mode in which they act, whether we consider the subject with reference to existing volcanos, or to that more general volcanic action to which we refer all the geological phenomena of elevation. Many speculations respecting actual volcanos have rested on the hypothesis of a direct communication, by means of the volcanic vent, between the surface and the fluid nucleus beneath, assuming the fluidity to commence at a depth little, if at all, greater than that at which the temperature may be fairly presumed to be such as would suffice, under merely the atmospheric pressure, to fuse the matter of the earth's crust*. When it is proved, however, that that crust must be several hundred miles in thickness, the hypothesis of this direct communication is placed, as I conceive, much too far beyond the bounds of all rational probability to be for an instant admitted as the basis of theoretical speculations. We are necessarily led, therefore, to the conclusion that the fluid matter of actual volcanos exists in subterranean reservoirs of limited extent, forming subterranean *lakes*, and not a subterranean *ocean*. Such also we conclude from the present thickness of the earth's crust, must have been the case for enormous periods of time; and, consequently, that there is a very high degree of probability that the same was true at the epochs of all the great elevations which we recognize, with the exception, perhaps, of the earliest. If, moreover, we find that the hypothesis of the existence of these subterranean lakes at no great depth beneath the surface, does enable us to account distinctly, by accurate investigations founded on mechanical principles, for the phenomena of elevation and the laws which they follow, then have we all the proof of the truth of our hypothesis which the nature of the case will admit of. These investigations I have given in my memoir on Physical Geology, published in the sixth volume of the Transactions of the Cambridge Philosophical Society. The fundamental

* Some of the most ingenious and determinate speculations of this kind are contained in a paper by Professor Bischoff, in the Edinburgh New Philosophical Journal for 1838–39. His views respecting the immediate agency by which volcanic action is produced will be equally applicable, whether the reservoir of volcanic matter beneath be of limited extent, or the central nucleus itself.

hypothesis of these investigations is thus found to be in perfect harmony with the results of the remoter researches contained in this and my two preceding memoirs.

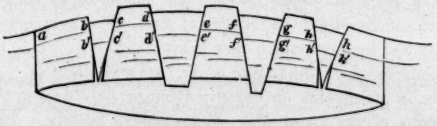
9. A question here arises as to the origin and continued existence of these insulated fluid masses enveloped in the solid portions of the earth. It would seem probable, I think, that their origin may be ascribed to the greater fusibility of the matter composing them; and their continuance in a state of fluidity may, I conceive, be accounted for partly by the same cause, and partly by another which I will proceed to explain.

Let us conceive an internal lake to have been formed as above supposed, or in any other manner, at a temperature which would just admit of the containing rock becoming solid, while it sufficed to preserve the fluid mass in a state of fusion. Let us then suppose an elevatory force, produced by the expansion of the fluid matter*, to raise the superincumbent solid mass, and to form in it a system of fissures. The plane of these fissures will scarcely ever be exactly parallel, and therefore will meet if sufficiently produced. Let the annexed diagram represent a transverse section of



(1.)

the system the instant after their formation, and before any relative displacement by further elevation, of the portions of the general mass contained between contiguous fissures, and forming so many complete or truncated wedges. The formation of these fissures will be completed at nearly the same instant of time†. Conceive the mass to be then still further uplifted. If every portion were raised equally, the width of the fissures would be increased, but such will not be the case. For the complete wedges, not reaching down to the fluid mass, will not be immediately acted upon by it at all, and the truncated wedges, whose narrower sides are downwards, will be acted on by the fluid pressure with less force in proportion to their masses, than those of which the broader sides are downwards. These latter portions, therefore, will be more elevated than the others, and the whole will assume a position like that represented in the following diagram. When the wedges have assumed these positions, it



(2.)

* Whatever difficulty there may be in fully explaining the causes of such expansion, there can be no doubt of the existence of such causes in aggregations of matter in a state of fusion as here supposed. The intensity with which they may act is attested by actual volcanos, as well as by the masses which must have been ejected at former epochs, in a state of fusion.

† See memoir on Physical Geology, above referred to.

will be impossible for the mass to subside, when the elevatory force shall cease, into that position which it originally occupied. It will be formed into an arch capable (if its abutments be sufficiently strong) of entirely or partially supporting itself. Consequently, if the cause producing the intumescence of the fluid mass cease to act, and that mass return nearly to its original dimensions, the pressure of the superincumbent solid mass may, in the manner now described, be entirely or partially removed from the fluid. Hence, assuming that solidification is promoted by great pressure, it evidently appears how a portion of the interior mass might be maintained in a state of fluidity by the removal of a superincumbent pressure, which would otherwise have brought it to a state of solidity.

It is not here essential to suppose that the arch shall entirely support itself. It may be partly supported by the fluid beneath, or it may break down in certain points, or along certain lines, and form there new supports, intermediate to the extreme ones. Instead of one continuous internal lake, a number may thus be formed, connected with each other by more or less obstructed channels of communication, as I have supposed in the exposition of my theoretical views on the Elevation of the Wealden District, recently laid before the Geological Society. It is the existence of subterranean lakes under this form, which best enables us, as I conceive, to account for the observed phenomena of elevation.

10. The above view of the relative displacements of the different portions of an uplifted and disrupted solid mass, as resulting from its geological elevation, is strongly confirmed by its enabling us to account so completely for the law, first recognized by Mr. Phillips, and which I have myself verified in numerous instances, in the relative displacement of the beds on opposite sides of a fault. In diagram (2.) we observe that the line $f' g'$ is relatively depressed below $e f$, with which it was originally continuous; *i. e.* the beds are *lowest* on that side of the fault *towards* which the plane of the fault inclines from the vertical in *descending*. This precisely accords with the law above alluded to. It will be observed to hold at each of the faults represented in the diagram, and probably admits of fewer exceptions than almost any other law observable in the phenomena of elevation.

§. *Permanence in the Inclination of the Earth's Axis.*

11. To the conclusions above deduced from the investigations of my two preceding memoirs, I may add that of the permanence in the mean inclination of the earth's axis to the plane of the ecliptic. This permanence has been frequently insisted on, and is highly important with reference to our speculations on the causes of those changes of superficial temperature which certain geological phenomena seem so unequivocally to indicate. The proof, however, which has hitherto been given of this constancy of inclination has rested on the hypothesis of the entire solidity of the globe, an assumption which, whatever may be the actual state of our planet, can never be admitted as necessarily applicable to it at all past epochs of time, at which organic

forms may have existed on its surface. My previous investigations have now demonstrated the truth of this conclusion as applicable to the earth from the first formation of its external solid shell. All such hypotheses, therefore, as have sometimes been made with respect to a change in the position of the earth's axis are entirely excluded, whether we suppose the interior of the earth to be now, or to have been heretofore, solid or fluid. A fact also, in itself not uninteresting, is thus established in the earliest history of our globe.

Nor would it have been possible, I conceive, to arrive at this result by any general considerations immediately derivable from the nature of our problem, and independent of its complete solution. The investigations contained in my two preceding memoirs were, in fact, commenced under the impression that the solution of this problem of the precession and nutation of the earth's axis on the hypothesis of the interior fluidity of the earth, would probably lead to results different from those which had been long before obtained on the supposition of the earth's entire solidity. This impression was founded on the consideration of the great difference between the direct action of a force on a solid, and that on a fluid mass, in its tendency to produce rotatory motion. We have seen, in fact, that the disturbing forces of the sun and moon do not tend to produce directly any motion in the interior fluid, in which the rotatory motion causing precession and nutation, is produced indirectly by the effect of the above forces on the position of the solid shell. A modification is thus produced in the effects of the centrifugal force, which (as appears from the results of our investigations) compensates for the want of any direct effect from the action of the disturbing forces. This compensation will scarcely, perhaps, be deemed less curious than many of those which have been recognized in the solar system, and by which, amidst apparently conflicting causes, its harmony and permanency are so beautifully preserved.

§. *Condition respecting the Temperature of Fusion for the matter composing the Earth, in order that its actual Temperature may be due to its original Heat.*

12. There is also another conclusion to be drawn from our investigations which it may be worth while to notice. It has been assumed in these memoirs that pressure is effective in producing solidification; it has been already remarked, however, that should that not be the case, our conclusions respecting the thickness of the earth's crust will still, *à fortiori*, be true. Our determination, therefore, of the least limit to that thickness is independent of this unknown effect of pressure, or, in other words, of the experimental determination of the temperatures of fusion for different substances under high pressures. With the aid of a proper series of experiments on this point, a direct method of arriving at an approximation to the thickness of the crust of the globe, or rather, to its least limit, might be easily explained. I shall not here, however, enter into any discussion on this subject. The conclusion to which I would now direct attention is this—the present temperature of the interior of the earth cannot be due to its original heat, if the temperature of fusion for the matter composing

it be independent of the pressure to which the fused matter is subjected. For if the terrestrial temperature be due to that source, it must undoubtedly be sufficient at the depth of one-fortieth or one-fiftieth of the earth's radius, to fuse all the rocks composing the superficial solid portion of the globe placed under the atmospheric pressure. Consequently matter must exist at such depths in a state of fusion, and the crust of the earth must be extremely thin, unless its solidification has been promoted by pressure. I have shown, however, that the crust of the globe cannot be very thin, and therefore the truth of our proposition is manifest.

There is also another mode, independent of our results respecting precession, by which we arrive at the same conclusion. Making the assumption just stated respecting the origin of the actual terrestrial heat, there is no doubt of its being immensely greater at the earth's centre than that which would be necessary to reduce the matter composing the earth's surface, under the atmospheric pressure, to a state of fusion. It would probably reduce a large portion of it to a state of vapour. Now this actual central temperature must necessarily be at least something less than that which existed at the time of the earth's incipient solidification, whether the solidification commenced at the centre or surface (Mem. I.). If it began at the centre it must have been owing to the predominance of pressure in promoting solidification over high temperature in opposing it, and the truth of our proposition is therefore involved in this hypothesis. Again, suppose the solidification to have commenced at the surface. In this case it has been shown (Mem. I.) that the whole mass would arrive at that state in which the fluidity would just become imperfect, at nearly the same time. The superficial temperature would then be just that of *perfect fusion* under the atmospheric pressure for the matter constituting the earth's surface, which, as just stated, must be small compared with the actual central temperature, and, *à fortiori*, small compared with the central temperature at the epoch referred to. Consequently, at that epoch, the central and superficial parts of the earth, under widely different temperatures, would have the same degree of fluidity, viz. that at which it just became *imperfect*, or that at which the component particles would cease to move among themselves in the process of cooling. If then τ_1 denote the temperature of *perfect fusion* for a point of the earth's mass at any depth beneath its surface (or the temperature at which the mass would there acquire perfect fluidity), τ_1 must be some function of the pressure at the proposed point. Also let τ_2 denote the temperature of *incipient fusion* at the same point (or that at which the matter then under the same pressure would just lose its property of solidity), then the question is, whether τ_2 be a function of τ_1 or not. Now that there should be some necessary relation between τ_1 and τ_2 would scarcely seem to admit the possibility of a doubt. But in such case τ_2, being a function of τ_1, must depend on the pressure. Hence it follows, as before, that the temperature of fusion of the earth's mass must depend on the pressure to which it is subjected, assuming always that the fusibility of the matter composing the central portion of the globe is not extremely different from that which constitutes its surface.

IV. *On the Structure and Use of the Malpighian Bodies of the Kidney, with Observations on the Circulation through that Gland.* By W. Bowman, *F.R.S., Assistant Surgeon to the King's College Hospital, and Demonstrator of Anatomy in King's College, London.*

Received February 14,—Read February 17, 1842.

THESE remarkable bodies have been an object of much interest since their discovery by the great anatomist whose name they bear. Malpighi found they could be injected with great facility from the arteries, and he imagined them to be glands, in which the urine is elaborated from the blood. He seems also to have been of opinion that in them the uriniferous tubes take their rise*. Ruysch examined them with great care, and preserved specimens in his museum in which he believed that he had shown, by injection, that in them the arteries are continuous with the tubes†. This was the principal ground for the famous, but now exploded theory, of the existence of exhalant arteries with open mouths, which in the secreting glands opened directly into the excretory canals. It is probable that this accurate observer mistook the efferent vessel of the Malpighian body for a uriniferous tube, for the efferent vessels of those Malpighian bodies that lie near the medullary part of the kidney, take the same course as the tubes, and are often large enough to be readily mistaken for them. The statement, however, of Ruysch and others‡, that the tubes may be injected from the arteries, is true, though in a different sense from that in which they understood it.

Schumlansky§, some years afterwards, entertained more complete views of the connection between these bodies and the uriniferous tubes, and he has even given an ideal diagram of this connection, which shows that he had a very clear conception of the fact. From a considerable error, however, in the proportion of these bodies to the tubes (represented in his figure), it has been suggested that his description could not have been drawn from nature; a censure that seems to have been little merited.

* See his chapter "de internis glandulis renalibus, earumque continuatione cum vasis," a work not less conspicuous for the sterling accuracy of its observations than for the sagacity displayed in the reasonings based on them.

† "Quarum (gland. Malpigh.) nonnullæ hîc dissolutæ, in ductus Bellinos degenerant."—Ruyschius, Thesaurus Anat. x. No. 86. "Corpuscula rotunda et glandiformia in totum sunt dissoluta et extricata. Ductus qui dicuntur Bellini, in totum quoque repleti sunt propter repletionem arteriolarum."—Ibid. No. 149.

‡ Bernardus Albinus, after injecting the Malpighian bodies from the arteries, "vasa urinæ exinde prodeuntia eodem colore farta beatus conspexit."—Albinus, p. 63, 64. Vide Schumlanskii Dissert. Inaug. Anatomicam de renum structurâ. Argentorati, 1782, p. 69.

§ Schumlansky, *op. cit.*

Huschke* and Müller† are the only modern anatomists who have entered at length into this question, and they both deny that there is any connection between the Malpighian bodies and the uriniferous ducts. The assertions of Müller, in particular, are so positive, and are reiterated in so pointed a manner, that nothing but the most clear demonstration of their erroneous nature would have induced me to uphold an opposite opinion‡.

I was led to the examination of these bodies in the course of an inquiry into the ultimate structure of the true glands, in which I have been engaged for the last two years. I had frequently injected them from the artery, but had never inspected them under high powers of the microscope, until they arrested my attention while examining the structure of the uriniferous tubes. These tubes consist of an external tunic of transparent homogeneous tissue (which I have termed the *basement membrane*), lined by epithelium. The Malpighian bodies I saw to be a rounded mass of minute vessels invested by a cyst or capsule§ of precisely similar appearance to the basement membrane of the tubes. Seeing these similar tissues in such close proximity, it was not easy to resist the conviction that the capsule was the basement membrane of the tubes expanded over the vessels, but, after many trials, I could not at that time succeed in gaining an unequivocal view of their continuity. All that I could accomplish was to perceive here and there an ambiguous approach to such an arrangement, sufficient to make it appear probable.

I should perhaps have relinquished the idea thus presented to my mind, had not accident again drawn me to it. Having, during last summer, been made acquainted, through the kindness of Dr. Milne Edwards, with a new method of injection employed with great success by M. Doyère of Paris‖, I injected some kidneys through the artery, by this method, in order to notice the nature of the vascular ramifications in the Malpighian bodies. I not only found what I sought, but the clearest evi-

* Huschke, Ueber die Textur der Nieren. Isis, 1828, p. 561.

† Joh. Müller, de Glandularum secernentium structurâ penitiori. Lipsiæ, 1830, lib. x.

‡ Huschke says (quoted by Müller), "These corpuscles (Malpighian bodies) are without any connection with the uriniferous ducts. For these most distinctly terminate by free blind extremities, while the Malpighian bodies, everywhere scattered in the interstices of the tortuous uriniferous ducts, are only connected with the blood-vessels."—Müller, *loc. cit.*, p. 87.

Müller says, "Attamen certissimum est, ex vasis sanguiferis, ductus uriniferos planè nunquam usquam repleri, massamque injectam ne quidem laceratione in tubulos uriniferos prorumpere," *op. cit.*, p. 98. "Fines ductuum uriniferorum in corpora Malpighiana desinere, certissimè falsa assertio est," p. 95. "Falsissima est opinio de connexu ullo quopiàm inter corpora Malpighiana sanguifera, et ductuum uriniferorum fines," p. 95. And other passages equally strong might be quoted.

§ First particularly pointed out by Müller, who conceives it to be perfectly closed, except at one point where perforated by the vessels.

‖ This consists of two fluids which mingle in the small vessels, and cause a precipitation there. The best fluids are saturated solutions of bichromate of potass and of acetate of lead. They are injected in succession through the same vessel, whence the method is termed that by *double injection*. Krause published an account of it two years ago, but M. Doyère appears to have arrived at it after a laborious trial of numerous solutions. Both deserve the thanks of anatomists for so valuable an addition to the means of investigation.

dence that the capsule which invests them is, in truth, the basement membrane of the uriniferous tube expanded over the tuft of vessels. The injected material had, in many instances, burst through the tuft, and, being extravasated into the capsule, had passed off along the tube. I have since made numerous injections of the human kidney, and of that of many of the lower animals, and in all, without exception, have met with the same disposition. I have also repeated, with better success than before, the examination of thin slices of the recent organ with high powers of the microscope, and in this manner have fully corroborated the evidence furnished by injections. This mode of examination has likewise led to the interesting discovery of ciliary motion within the orifice of the tube.

According to my own observations, the circulation through the kidney may be stated to be as follows:—All the blood of the renal artery (with the exception of a small quantity distributed to the capsule, surrounding fat, and the coats of the larger vessels) enters the capillary tufts of the Malpighian bodies; thence it passes into the capillary plexus surrounding the uriniferous tubes, and it finally leaves the organ through the branches of the renal vein. Following it in this course, I shall now endeavour to describe the vascular apparatus, and the nature of its connection with the tubes.

With the inconsiderable exceptions just mentioned, the terminal twigs of the artery correspond in number with the Malpighian bodies. Arrived here*, the twig perforates the capsule, and, dilating, suddenly breaks up into two, three, four, or even eight branches, which diverge in all directions like petals from the stalk of a flower, and usually run, in a more or less tortuous manner, subdividing again once or twice as they advance, over the surface of the ball they are about to form. The vessels resulting from these subdivisions are capillary in size, and consist of a simple, homogeneous, and transparent membrane. They dip into its interior at different points, and after further twisting, reunite into a single small vessel, which varies in its size, being generally smaller, but in some situations larger than the terminal twig of the artery. This vessel emerges between two of the primary divisions of the terminal twig of the artery, perforating the capsule close to that vessel, and, like it, adhering to this membrane as it passes through. It then enters the capillary plexus which surrounds the tortuous uriniferous tubes†.

The tuft of vessels, thus formed, is a compact ball, the several parts of which are held together solely by their mutual interlacement, for there is no other tissue ad-

* As the mode of subdivision of this artery in the interior of the organ is well known, I have omitted to describe it. Its branches never anastomose. It almost invariably happens that the twigs ending in the Malpighian bodies are of considerable length, but occasionally (as in fig. 8) two bodies are sessile on very short twigs of a single branch.

† "Cæterùm glomeruli ulterior conformatio in præstantissimis quamvis injectionibus non facilè extricari potest. Videor tamen observasse arteriolam, quæ glomerulo accedit, cirri adinstar dividi, unde tortuosa vascula oriuntur, quæ ansis secum arctè connectuntur et recurrunt. Sed hoc certum est, glomerulos liberè in vesiculis contineri, nec ullibi, nisi uno in puncto, cum vesiculis cohærere."—Müller, *loc. cit.*, p. 101.

mitted into the capsule besides blood-vessels. It is subdivided into as many lobes as there are primary branches of the terminal twig or afferent vessel, and these lobes do not communicate, except at the root of the tuft. There are, therefore, deep clefts between them, which open when the lobes are not greatly distended with injection or blood. The surface of the tuft is everywhere unattached and free, and continuous with the opposed surfaces of the lobes. The whole circumference of every vessel composing the tuft, is also free, and lies loose in the cavity of the capsule. These circumstances cannot be seen in specimens gorged with injection, but only by careful examination of recent specimens with a power of 200 or 300 diameters. The vessels are so perfectly bare, that in no other situation in the body do the capillaries admit of being so satisfactorily studied. It is only where the tuft is large, as in Man and in the Horse, that its lobulated character can be always discerned. When the number of primary subdivisions of the afferent vessel is smaller, the detection of lobes is less easy. They may often be seen, however, in the Frog. In Birds and Reptiles, the afferent vessel seldom divides, but dilates, instead, into a pouch-like cavity, which, after taking two or three coils, contracts again and becomes the efferent vessel. Here of course there are no lobes; but the surface of the whole dilated part is free.

The basement membrane of the uriniferous tube, expanded over the Malpighian tuft to form its capsule, is a simple, homogeneous, and perfectly transparent membrane, in which no structure can be discovered. It is perforated, as before stated, by the afferent and efferent vessels, and is certainly not reflected over them. They are united to it at their point of transit, but in what precise manner I have not been able to determine. Opposite to this point is the orifice of the tube, the cavity of which is continuous with that of the capsule, generally by a constricted neck. I have specimens prepared with the double injection showing this continuity in Mammalia, Birds, Reptiles and Fish; and, in Mammalia and Reptiles, I have obtained the still more satisfactory proof afforded by a clear view of the whole of the textures magnified 300 diameters. As the Malpighian bodies are placed in every possible direction, it often happens that a thin section, parallel to the neck of the tube, cannot at once be obtained: but with perseverance this may always be done. The capsule is then seen to pass off into the basement membrane of the tube, as the body of a Florence flask into its neck. The basement membrane of the tube is lined by a nucleated epithelium of a finely-granular opake aspect, while the neck of the tube and its orifice become abruptly covered with a layer of cells much more transparent, and clothed with vibratile cilia. The epithelium is continued in many cases over the whole inner surface of the capsule; in other instances I have found it impossible to detect the slightest appearance of it over more than a third of the capsule. When fairly within the capsule, the cilia cease, and the epithelium beyond is of excessive delicacy and translucence. Its particles are seldom nucleated, and appear liable to swell by the addition of the water added to the specimen. They frequently fill up the space between the capsule and tuft, and touching the latter, may seem to be united to it.

The lines of their mutual contact may then wear the aspect of a highly delicate areolar tissue, connecting the capsule with the tuft. The cavity existing in the natural state between this epithelium and the tuft, is filled by fluid, in which the vessels are bathed, and which is continually being impelled along the tube by the lashing movement of the cilia. In the Frog, where alone I have as yet been able to see these wonderful organs in motion, they were longer than those from other parts of that animal, and extremely active.

The tubes, on issuing from the Malpighian bodies, invariably become greatly contorted. I have on one occasion seen two of them unite, and from their dichotomous mode of division, when traced up from the pelvis, there can be little doubt that this is constantly their disposition. I have never, in all my examinations, met with any appearance of an inosculation between different tubules. The tortuous tubes unite again and again in twos, and finally, under the name of pyramids of Ferrein, become straight, and converge towards the pelvis, forming the medullary cones or pyramids of Malpighi. The Malpighian bodies are imbedded in a kind of nidus formed among these convolutions, and are touched on all sides by the surrounding tubes. As the emergence of the tube from the Malpighian body can be seen only at one point, it is not wonderful that it should have been overlooked, and that the demonstration should have seemed clear, that the Malpighian bodies merely lie among the tubes, and have no connection with them.

The blood, leaving the Malpighian tufts, is conveyed by their efferent vessels to the great renal reservoir, the capillary plexus surrounding the uriniferous tubes. This, in its general arrangement, resembles that investing the tubes of the testis. The vessels lie in the interstices of the tubes, and everywhere anastomose freely, so that throughout the whole organ they constitute one continuous network, lying on the outside of the tubes, in contact with the basement membrane. This plexus is interposed between the efferent vessels of the Malpighian bodies and the veins.

The efferent vessels of the Malpighian bodies are always solitary and never inosculate with one another: each one is an isolated channel between its Malpighian tuft, and the plexus surrounding the tubes. They are formed by the union of the capillary vessels of the tuft, and emerge from its interior in the manner already explained. After a course of variable length they open into the plexus. Their size is various. In general, they are smaller than the terminal twig of the artery, and scarcely, if at all, larger than the vessels of the plexus into which they discharge themselves. But where the Malpighian tuft is large, the efferent vessel is usually large also, and divides into branches before entering the plexus. This is eminently the case with those situated near the base of the medullary cones, where the medullary and cortical portions of the organ seem to blend. The efferent vessels from these large Malpighian bodies are often three or four times the diameter of those of the plexus, and take a course towards the pelvis of the kidney between the uriniferous tubes. They were formerly mistaken for tubes. They branch again and again in the manner of arteries,

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and form the plexus with long meshes which invests this part of the tubes. Some of the veins springing from this plexus form the well-known network on the nipple-shaped extremities of the cones, around the orifices of the tubes, and thence take, with the remainder, a backward course, likewise parallel to the tubes, to empty themselves into venous branches that lie about the bases of the cones. These also, when injected, have been mistaken for tubes.

The other venous radicles are dispersed at about equal distances throughout the cortex of the kidney, and each receives the blood on all sides from the plexus surrounding the convoluted tubes. When these venous radicles are congested, or injected, they mark out the surface of the cortical substance into lobules not very unlike those of the lobules of the liver. On the Horse's kidney, especially, this may be often well seen. Each lobule contains many tortuous ducts with their capillaries, but the convolutions of any one duct are not confined to a single lobule. These radicles unite in an irregularly arborescent figure, anastomose and form the several branches of the renal vein. Those on the surface, especially of the human kidney, have a tendency to converge towards a central vessel which then dips into the interior, and runs, like the rest, towards the hilus. Thus are formed the stellated vessels of anatomists, often conspicuous in diseased specimens. Between the sprawling arms of these stellæ the convoluted tubes, with their plexus, come up to the surface (Plate IV. fig. 11), but the Malpighian bodies are rarely, if ever, visible quite on the surface. They are always covered in by convolutions of the tubes.

The veins from the capsule and surrounding fat join the renal vein in some part of its course. It is probable that the capillaries of the vasa vasorum, within the substance of the organ, pour their blood into the capillary plexus surrounding the tubes, as those of the hepatic artery do into the portal-hepatic plexus of the lobules of the liver.

Thus there are in the kidney *two perfectly distinct systems of capillary vessels*, through both of which the blood passes in its course from the arteries into the veins: the 1st, that inserted into the dilated extremities of the uriniferous tubes, and in immediate connection with the arteries; the 2nd, that enveloping the convolutions of the tubes, and communicating directly with the veins. The efferent vessels of the Malpighian bodies, that carry the blood between these two systems, may collectively be termed the *portal system of the kidney*. To these distinct capillary systems, I am inclined to attribute distinct parts of the function of the organ; and their importance seems to warrant a few words, in further explanation of their anatomical differences.

The former, which may be styled the Malpighian capillary system, is made up of as many parts as there are Malpighian bodies. These parts are entirely isolated from one another; and, as there is no inosculation between the arterial branches supplying them, the blood enters each in a direct stream from the main trunk. This capillary system is also highly remarkable, indeed stands alone among similar structures, in being *bare*. The secreting tubes of the kidney, like those of all other glands, are,

strictly speaking, an involution of the outer tegument of the frame: their interior is, in one sense, the outside of the body: their walls intervene between the vessels and the exterior, and, as it were, cover them in. But here is a tuft of capillaries extruded through the wall of the tube, and lodged in a dilatation of its cavity, uncovered by any structure. Bare indeed, yet screened from injury in its remote cell, with infinite care and skill! Each separate part, also, of this system, has but one afferent and one efferent channel, and both of these are exceedingly small, compared with the united capacity of the capillary tuft. The artery in dividing, dilates: then follow branches which often exceed it in size, and which gradually break up into the finest. The efferent vessel does not usually even equal the afferent, and in size is often itself a capillary. Hence must arise a greater retardation of the blood in the tuft, than occurs probably in any other part of the vascular system; a delay that must be increased by the tortuosity of the channels to be traversed.

The other system of capillaries, or that surrounding the uriniferous tubes, corresponds, in every important respect, with that investing the secreting canals of other glands. It is well known to anatomists, and therefore does not require to be described at any length. Its vessels anastomose with the utmost freedom on every side, and lie on the deep surface of the membrane that furnishes the secretion.

I have applied the term '*portal system of the kidney*' to the series of vessels connecting these two, on account of the close analogy it seems to bear to the vena porta. The precise quality of the blood it carries may be doubtful, but in distribution it is similar. It intervenes between two capillary networks, the first of which answers to that in which the vena porta originates, and the second to that in which the vena porta terminates. The obvious difference lies in its several parts not uniting into a single trunk, to subdivide afterwards; but this circumstance seems to admit of an easy explanation. A trunk is formed in the great portal circulation, for the convenience of transport, most of the capillaries which supply it lying at a distance from the liver. Some, however, viz. those drawn from the hepatic artery, either enter the portal-hepatic plexus directly, (as Müller thinks, and as my preparations certainly show some of them to do,) or else join the minuter twigs of the portal vein, according to the opinion of Kiernan. Now, in the kidney, the vessels issuing from the Malpighian tufts are disseminated pretty equally throughout the plexus surrounding the tubes (the one into which they have to discharge themselves), and they therefore enter it at all points at once, without uniting. In the medullary cones, however, where there is a capillary plexus to be supplied with blood, but no Malpighian bodies nearer than the base of the cones, the conditions which oblige the formation of a portal venous trunk begin to operate; the two capillary systems it serves to connect are at some distance apart. Here, consequently, the Malpighian bodies are generally larger, their efferent vessels more capacious, and branched after the manner of an artery. *Each one of these efferent vessels is truly a portal vein in miniature.*

The capillary plexus surrounding the tubes differs, therefore, from that of other glands, and agrees with that of the liver, in its receiving blood that has previously traversed another system of capillary vessels. That other system is a peculiar one, as already pointed out, and cannot be likened closely to that which furnishes the portal vein of the liver.

The preceding account of the existence of a true portal system in the kidney of the higher tribes of Vertebrata was already written, when an opportunity presented itself of inspecting the distribution of the vessels in one of those lower animals, in which, besides the renal artery, the kidney is furnished with a portal vein, derived from the hinder part of the body. The presence of such a vein, though denied by MECKEL, was well established by NICOLAI, whose statements have been confirmed by others; but I am not aware that any anatomist has explained its remarkable distribution, and its connection with the other vessels*. I shall therefore introduce a summary account of my examination of the kidney of the Boa Constrictor (the animal in question), which may be regarded as a model of this variety; and I think it will be found not only to show the correctness of the analogy I have drawn between the efferent vessels of the Malpighian bodies and a portal system, but to place in a clearer light the other striking resemblances between the circulation of the liver and kidney.

The kidney of the Boa, being composed of isolated lobes, of a compressed reniform shape, displays all the points of its structure in peculiar simplicity and beauty. At what may be termed the hilus of each lobe, the branches of the vena porta and duct separate from those of the renal artery and emulgent vein; the two former spreading side by side, in a fan-like form, over the opposite surfaces of the lobe, while the two latter enter its substance, and radiate together in a plane midway between these surfaces. The lobe is made up of the ramifications of these four sets of vessels, in the following mode. Each *duct*, as it runs over the surface, sends down a series of branches which penetrate in a pretty direct manner towards the central plane. Arrived there, they curl back, and take a more or less retrograde course towards the surface, and finally, becoming more convoluted, terminate in the Malpighian bodies, which are all situated in a layer at some distance within the lobe, parallel to the central plane, and nearer to it than to the surface. The ducts never anastomose. The *artery* subdivides into extremely minute twigs, no larger than capillaries, which diverge on either hand, and enter the Malpighian bodies. The efferent vessels are of the same size as the afferent, and on emerging, take a direct course to the surface of the lobe, and join the branches of the vena porta there spread out. The branches of the *portal vein* on the surface, send inwards a very numerous series of twigs of nearly uniform capacity, and only a little larger than the vessels of the *capillary plexus*, in which

* HUSCHKE, who seems to have entered into the greatest detail on this subject, states that he was unable to ascertain in the Serpent's kidney, whether the twigs of the artery were distributed to the Malpighian bodies or not. In the Frog, however, he describes the Malpighian bodies as appended to the terminal twigs of the artery. Isis, 1828, p. 566–7.

they almost immediately terminate. This is the plexus surrounding the uriniferous tubes. It extends from the surface to the central plane of the lobe, and there ends in the branches of the *emulgent vein*.

Thus the efferent vessels of the Malpighian bodies are radicles of the portal vein, and, through the portal vein, empty themselves, as in the higher tribes, into the plexus surrounding the uriniferous tubes. The only real difference between this form of kidney and that of Mammalia, is, that there is here a vessel bringing blood that has already passed through the capillaries of distant parts, to be added to that coming from the Malpighian bodies, and to circulate, with it, through the plexus surrounding the tubes. The efferent vessels of the Malpighian bodies run up to the surface in order to throw their blood through the whole extent of the capillary plexus; which they would fail to do, if they entered it in any other part.

I have described the renal artery as being spent upon the Malpighian bodies; but in the hilus of the lobe it gives off, as in the higher animals, a few slender twigs to the coats of the excretory ducts and of the larger vessels. The capillaries of these twigs are easily seen, and, in all probability, discharge themselves into the branches of the portal vein.

The circulation through this form of kidney, may be aptly compared with that through the liver, as described by Mr. KIERNAN in his invaluable paper on that gland. The plexus surrounding the tubes corresponds with the portal-hepatic plexus, which, in the lobules of the liver, invests the terminal portions of the bile-ducts. Both these plexuses are supplied with blood by a portal vein, derived chiefly from the capillaries of distant organs, but in part from those of the artery of the respective organs themselves. The only difference seems to be, that, while, in the liver, the branches of the artery are entirely given to the larger blood-vessels, ducts, &c., in the kidney, a few only are so distributed, the greater number going through the Malpighian bodies, to perform an important and peculiar function. In both glands, however, all the blood of the artery eventually joins that of the portal vein. The emulgent vein of the kidney answers to the hepatic vein of the liver.

The *comparison between the hepatic and renal portal circulation* may be thus drawn in more general terms. The portal system of the liver has a double source, one extraneous, the other in the organ itself: so, the portal system of the kidney, in the lower tribes, has a two-fold origin, one extraneous, the other in the organ itself. In both cases the extraneous source is the principal one, and the artery furnishing the internal source is very small. But in the kidney of the higher tribes, the portal system has only an internal source, and the artery supplying it is proportionally large.

The above account appears to me to comprise whatever is most important in the anatomy of the blood-vessels and ducts of the kidney. My object in it has been to convey an idea of the physiological anatomy of the gland, and I have therefore omitted to mention (except where it suited my purpose) those rougher characters of the kidney in the various classes, that result from varieties in the mode of aggregation of

its several constituent parts. The principal of these are well known, and it would have diverted attention too much to delineate others, especially as such peculiarities are of trifling moment. The accompanying illustrations I have endeavoured to execute with scrupulous fidelity after nature. The injected specimens from which several of them are taken, are, with numerous others, in my possession, and those that can be examined only in a recent state, may usually be prepared with facility.

I shall now state the results of my injections of the kidney of Man and the higher animals by the arteries, veins, and ducts, in order to show their accordance with the view I have given of the nature of the Malpighian bodies, and of the vascular apparatus of the organ. This may be also desirable for purposes of comparison with the statements of other anatomists (which, to avoid prolixity, I have not referred to in detail); and it will, besides, give a full opportunity of testing the correctness of my statements, to those inquirers who may be disposed to do so*.

By the Arteries, *the Malpighian Tufts can be injected with great facility, and also, with less freedom, the Capillaries surrounding the uriniferous tubes. The Tubes also may be injected, by extravasation from the Malpighian tufts.*

The course of the injection to the tufts is direct and free. The arterial tree is of small capacity, and there is seldom so much blood in it after death as to impede the flow of the artificial fluid. My preparations show this tree injected in various degrees, by the double fluid (Plate IV. figs. 1 to 14). In some, the tufts are full, the afferent and the efferent vessels are both seen, as well as the communication of the latter with the plexus surrounding the tubes (figs. 2, 4, 5, 6). In others, the vessels of the tuft have given way under the pressure of the fluid, which has then escaped into the capsule and often into the tube also† (figs. 4, 9, 10, &c.). Sometimes the injection has passed freely and without extravasation through only a portion of the Malpighian tuft, leaving the rest filled with blood, which could not have happened to an unbranched coil of vessel, as this tuft is by some described‡. In these, the afferent and the efferent vessels are both injected, but only a fragment of the tuft (fig. 2). Sometimes the injected fluid has burst out immediately on entering the first branches

* It is worthy of notice, as showing both the difficulty of the subject and the uncertain state of our knowledge up to the present time, that Berres, the distinguished Professor of Vienna, in his recently published work on microscopical anatomy, maintains the existence of a direct inosculation of the uriniferous tubes with the capillary plexus surrounding them. After the description already given, I need hardly say, that this view seems to me, for many reasons, altogether untenable.

† I have great pleasure in stating that my friend Mr. Tomes, three years ago, during his examination of numerous kidneys that he had injected, saw two or three examples of this escape of the injection along the tube; of one of which he has preserved a rough outline. Not being able to see it again he gave up the search. I have no doubt that he communicated this fact to me in conversation at the time, though I cannot now recollect his doing so. The first drawing I made of the tube expanded over the tuft, I find dated February 17, 1841; about which time my interest in the subject was first excited.

‡ Of course this never occurs in Birds, where the Malpighian vessel is a coiled ampulla.

of the tuft: it has then insinuated itself between the ball of vessels and the capsule, and has run off along the tube. In this case the tuft is left uninjected and containing blood, and it becomes enveloped in a film of injection (fig. 9). Sometimes one side only of the tuft is injected at the moment when extravasation occurs, sometimes the whole, and likewise the efferent vessel (figs. 3, 4). In general, the capsule, when thus filled with extravasated injection, has a perfectly smooth external surface, but when the tuft within is also much distended, this may, in the dried and somewhat collapsed specimen, give to the outer surface of the capsule an uneven appearance like that of the tuft itself. The capsule, when distended, is seen in many instances to bulge and form a prominent circle round the point at which the vessels enter and emerge. The vessels then appear to lie in a small pit or fissure before becoming connected with the tuft (fig. 9). Lastly, it occasionally happens that though extravasation has occurred into the capsule, the fluid has not spread itself over the whole surface of the tuft, and yet has passed off along the tube (figs. 3, 10, *m*, *m*). As the tubes in the human kidney usually become very tortuous immediately on leaving the Malpighian bodies, the injection running off along them may often wear the appearance of an irregular extravasated mass, and so its real nature escape observation*

* During the course of the researches detailed in this paper, I have embraced whatever opportunities presented themselves of studying the morbid conditions of the human kidney, and especially those usually known as the stages of BRIGHT'S disease. It would obviously have been little conducive to my present purpose to have entered here upon a general description of the results to which my inquiries on this interesting subject have led me, but I cannot forbear noticing one fact of considerable importance, which will both illustrate and be illustrated by the preceding account of the normal anatomy of the gland. It is well known that blood is often passed with the urine during the course of the disease, especially at the earlier periods of it, when many circumstances contribute to prove that the kidneys are in a state of sanguineous turgescence. How does this blood escape into the ducts of the gland? The organ examined at this time presents on its surface and throughout its cortical substance, scattered red dots, of somewhat irregular shape, not accurately rounded, and generally as large as pins' heads, that is, very many times larger than the Malpighian bodies. These spots are very visible on the surface, where, as I have before stated (p. 62), no Malpighian bodies exist. They have been nevertheless described by several recent writers (not without contention for the honour of the discovery) as Malpighian bodies enlarged from congestion. How a Malpighian tuft, such as I have described it, could attain so prodigious a bulk, prodigious compared with its natural size, it would not be easy to explain. It is true that, if examined with a lens, the blood forming these spots is found to be arranged in convoluted lines, but these convolutions are not the dilated vessels of the tuft. They are nothing less than *the convolutions of a tube filled with blood*, that has burst into it from the gorged Malpighian tuft at its extremity. This is at once evident to a person familiar with the appearance of the same tubes when filled with injection in a similar manner; and the figure, which I have taken from a healthy kidney so injected (fig. 11), might serve as an exact representation of one of these spots, as seen on the surface of the diseased organ. The more or less perfect plug, thus often formed in the tubes, is the occasion of those dilatations of the *tubes* and Malpighian *capsules*, which are to be met with in the more advanced stages of the disease. Thus is to be explained the somewhat loose statement, that the disease consists essentially in enlargement of the Malpighian bodies. Though I have examined with great care many kidneys at all stages of the complaint, I have never seen, in any one instance, a clearly dilated condition of the Malpighian tuft of vessels. On the contrary, my friend, Mr. BUSK, an excellent observer, has specimens which undoubtedly prove these tufts not to be dilated in the first stage, and I possess injected specimens showing them at all stages, but never above their natural size. I am far from implying,

(fig. 9). When size and vermilion are employed, this is very apt to occur*, and especially when the specimen injected is not fresh; for the epithelium soon loses its adhesion to the basement tissue of the tube, and, falling into the cavity, mingles with the stream of injection, and renders its course obscure. This lining of the tubules with a pavement of epithelium occasions a striking appearance in perfectly fresh specimens, when filled with double injection. This penetrating material insinuates itself into the interstices of the epithelial particles, and thus marks them out as a kind of pattern on the wall of the tube. When extravasation does not take place in the Malpighian bodies, more or less of the network surrounding the tubes is not unfrequently injected. The most perfect specimens of injected Malpighian tufts are then obtained; but the veins themselves are seldom well filled through the arteries, for not only is the way to them circuitous, and broken up into a thousand separate avenues (the Malpighian tufts), but it is usually loaded with blood. When injection is driven into any one branch of the renal artery, the several states now detailed are seen only in the parts to which that branch is distributed. There is no anastomosis between the branches in the interior of the gland.

It sometimes happens that in injections by the artery, extravasation is found to take place into the interstices of the tubes, with or without escape into the Malpighian capsules and tubes. This may arise from rupture either of the arterial tree, before reaching the Malpighian bodies (which is uncommon, where great force is not employed), or of the efferent vessels of those bodies, or of the network of the tubes, injected through them. It may also occur from rupture of a tube, which has been itself filled by the rupture of a Malpighian tuft.

By the Veins, *the Capillaries surrounding the tubes may be injected, but neither the Malpighian bodies, nor the arteries, nor, without extravasation, the tubes.*

The capillaries of the uriniferous tubes are of great aggregate capacity, and commonly contain much blood. When injection is pushed into the vein the whole organ instantly swells; so rapidly do these dilatable and freely inosculating channels receive the fluid impelled into them. By the numerous communications of the capillaries with the veins, it is at once dispersed in every direction, and enters the capil-

however, that these bodies are unconcerned in the train of morbid phenomena. They unquestionably are so, and even necessarily must be so, from their anatomical structure, but in what manner I shall not at present attempt to show.

* My friend Mr. Quekett, of the College of Surgeons, possesses many very excellent specimens of injected kidneys, in many of which he has been able to detect the tube passing from the Malpighian body, since his attention was directed to this arrangement. He also showed me a very beautiful injection of the Malpighian bodies in the Horse, sent over to the Microscopical Society of London by Prof. Hyrtl of Prague. In one corner of this we found a similar extravasation, though the disposition in question seems to have eluded the attention of that excellent anatomist. I am indebted to Mr. Quekett for some finely injected specimens of a boa's kidney, from one of which fig. 14. is taken.

laries by innumerable avenues. But towards the Malpighian bodies, there is no opening from this capillary network at all corresponding in magnitude or freedom to that on the side of the veins. In fact, the only points by which it can discharge itself are the efferent vessels of the Malpighian bodies, which are comparatively few in number, only capillary in size, and quite disconnected with one another, except through the plexus itself. Add to this, that the Malpighian tuft to which they lead is a great obstacle to the passage of fluid, from the tortuosity of its minute vessels, and by their all having but one point to discharge themselves of the blood they already contain, viz. their afferent vessel. Thus to fluid driven through the kidney in a retrograde course, there is not only the general impediment offered by the aggregate capacity of the arteries being greatly inferior to that of the veins, but a vascular arrangement equivalent to a double valve. The capillaries of the tubes form a first great cul-de-sac, those of the Malpighian tufts a second, for these may both be described as great reservoirs, easily entered from the side of the arteries, but discharging themselves with great difficulty back again, or towards the arterial tree. If it be now considered that the network of the tubes, or the former and far the greater of these reservoirs, almost always retains much blood after death, and that the Malpighian reservoir is never without a considerable quantity, it will not be difficult to comprehend, why injection thrown into the veins reaches not to the Malpighian bodies, however well it may seem to load the capillaries of the tubes; for all the blood must first pass through the difficult channels that have been spoken of, and this it never can do completely. I suppose that this view of the subject, which is nothing more than a statement of facts, will be deemed a sufficient explanation, and that it will not be regarded as necessary to imagine the existence of real valves in any part of the course of these small blood-vessels. I have never met with any appearance that could lend credibility to such a supposition, which, if true, would present an unique structure in the vascular system. Extravasation from the veins will sometimes reach the tubes, in consequence of a structure which will presently be explained.

By the Tubes, *the Malpighian bodies cannot be injected, nor, without extravasation, either the plexus surrounding the tubes, or the veins.*

Many anatomists have taken extreme pains to inject the tubes from the pelvis of the kidney, by means of the air-pump, but never has a single Malpighian body been thus filled. This, it has been said, is a conclusive proof that the Malpighian bodies are not placed at the extremities of the tubes. But I think that if the real structure and relation of these parts be duly considered, this constant result will be allowed to be in the strictest accordance with the account I have delivered, and even a necessary effect of the anatomical disposition of the parts. To those who are acquainted with the practical difficulties of the injection of the ducts of glands in general, and especially of those which are very tortuous, the following considerations on this subject

will probably appear conclusive. Even of the testis (where the tubes are far thicker and stronger in their coats, and much more capacious than in the kidney), there are not ten specimens that can be pronounced at all full, in the museums of Europe; and there is no evidence, that, even in the best of these, the injected material has reached the very extremities of the tubes.

In the kidney, the tubes are exceedingly tortuous after leaving the Malpighian bodies, and only become straight, in most animals, in proceeding towards the excretory channel to discharge themselves. The way towards their orifices is so free, in a natural state, that their fluid contents exert no distending force upon their walls. Accordingly their walls are exceedingly feeble; the basement membrane on which their strength mainly depends, is very delicate and easily torn. They are therefore incapable of offering much resistance to a fluid impelled into them from the pelvis, but burst readily, if it be forcibly urged. But were the coats ten times as tough as they really are, injection could not penetrate far into their convoluted portion, unless pushed with much force; and this for two reasons:—1st. The fluid which the tubes already contain has no means of escape before the injection, since these canals end by blind extremities in the Malpighian bodies; and though these bodies are dilatations of them, yet they are already filled almost completely by the tuft of capillaries, and offer no capacious receptacle for the fluid from the tubes. 2nd. The layer of epithelium (which usually forms about two-thirds of the thickness of every tube, the calibre being about one-third*) is, immediately after death, very prone to separate from the basement membrane which it lines, and to fall into and block up its narrow channel. Even if the epithelium remains in its place, the calibre of the tube is but small, and if it becomes detached, it opposes an effectual bar to the progress of the injection. By removing the pressure of the atmosphere from the outer surface of the tubes, these obstacles are occasionally in part overcome, so that even the tortuosities of the tubes are filled for a certain distance. But even so limited a success is rare, and in face of mechanical obstacles, such as above mentioned, to the onward current of the injection in the tubes, the force employed invariably sooner or later bursts their coats, ere their extremities have been reached. Extravasation from the tubes, as might be expected, fills their interstices, and the fluid may then issue by a rent at the hilus of the kidney. But it is remarkable how readily it enters the veins and absorbents from the ducts. This is undoubtedly by extravasation, and does not prove any continuity between them. The veins may be filled when the fluid has not penetrated in the tubes beyond the medullary cones, showing that the rupture must occur in connection with those cones, either at their apices or in their substance. By a thin transverse section of one of these cones, the ducts and blood-vessels of which they principally consist, are seen to be imbedded in a sort of matrix, apparently homogeneous, but probably having a cellular structure. This matrix keeps the tubes and

* These proportions vary considerably. The basement membrane is so thin that it may be left out of the estimate.

vessels open by being united to their outer coat, whence results the dark colour, usually attributed to congestion, which these cones commonly present, as compared with the cortical part, where this matrix is less abundant. This is the structural condition which seems to me most easily to explain the remarkable facility with which injection, urged along the tubes, enters the veins. The smallest rupture of the matrix will crack across the minute vessels accompanying the tubes, and expose their open extremities to the entrance of the injection. If the force employed be very moderate and equable, extravasation does not occur, and the tubes alone are injected, often to the surface, but undue or ill regulated pressure almost inevitably occasions it. Having once entered a small vein, through however small an opening, it soon diffuses itself through the veins, and the capillaries surrounding the tubes, rather than along the tubes, for the reasons above stated; and, if the organ be then cut to pieces and examined, these vessels seem filled, without extravasation; the tubes are also more or less filled with the same colour; and the two structures are so intricately interlaced, as to wear the aspect, especially if dried, of one continuous network. The point of extravasation escapes observation, and hence the fallacy of imagining a continuity between the veins or their capillaries, and the tubes.

Some distinguished anatomists have held that the tubes end in a plexiform manner, and have stated themselves to have unequivocally seen this arrangement in injected specimens. I am induced to believe this opinion to be founded on deceptive appearances; either such as that above mentioned, or that occasioned by the overlapping of injected tubes. Others have considered the tubes to terminate in free blind extremities unconnected with the Malpighian bodies, and have likewise rested their opinion on the appearances of injected specimens, as well as on those of recent ones. As the injection always stops short of the real extremities of the tubes (the Malpighian bodies), it must necessarily show apparent free extremities—and others may be produced by the section requisite for the examination of the part. As for the false appearances presented by recent specimens, they are obviously referable to the sudden bending down of a tube behind the part turned to the observer. In a mass composed of convolutions, many such must continually occur; and their real nature may be easily determined by the use of a high power and varying focus. Other anatomists, aware of this last fallacy, and failing to find either a free inosculation of the tubes in the form of a plexus, or a termination of them in the Malpighian bodies, have rested in the conclusion that the curves of the convoluted part are the looped junctions of different tubes. It is obvious that this conclusion is a deduction drawn from the apparent absence of any other mode of termination, and must be relinquished now that the tubes are shown to end in the Malpighian bodies.

The foregoing account has been drawn principally from my observations on the kidneys of Mammalia, but it is intended to embrace the chief points in the anatomy of the Malpighian bodies in all the Vertebrate tribes. In all these, I have ascertained

the Malpighian body to consist of the dilated extremity of the uriniferous tube, with a small mass of blood-vessels inserted into it. But in the several orders of animals, there are various modifications that merit notice. The most considerable of these regard the size of the Malpighian bodies, in connection with which are others in the mode of division of the arterial twig. The following Table exhibits this variety in their size, in a few species, and subjoined to each measurement, is that of the tube soon after its emergence. It will be seen that the tubes differ far less than the Malpighian bodies.

Table of the Diameter of Malpighian Bodies, and of the Tubes emerging from them in Fractions of an English Inch.

	Diameter of Malpighian bodies.			Diameter of tubes.
	Maximum.	Mean.	Minimum.	
Man	1/80	1/164	1/244	1/480
Badger	1/164	1/184	1/270	1/418
Dog	1/140	1/182	1/278	1/260
Lion	1/70	1/80	1/90	1/318
Cat	1/278	1/260	1/270	1/280
Kitten	1/208	1/280	1/318	1/1000
Rat	1/208	1/270	1/270	1/418
Mouse (*Mus*)	1/220	1/253	1/318	1/770
Squirrel (*Sciurus vulgaris*)	.....	1/207	.....	1/770
Rabbit (*Lepus Cuniculus*)	.....	1/270	.....	1/253
Guinea Pig (*Cobaya*)	.....	1/208	.....	1/260
Horse	1/33	1/70	1/90	1/418
Parrot (*Psittacus*)	.....	1/130	.....	1/260 to 1/700
Tortoise (*Testudo*)	.....	1/140	.....	1/280
Boa	1/130	1/160	1/240	1/240
Frog (*Rana*)	.....	1/230		
Eel (*Anguilla vulgaris*)	.....	1/207		

The kidney of the Boa shows very beautifully the reason of the different size of the Malpighian bodies in different parts of the same gland observed in all animals; and also one cause of the striking difference in their size in different animals, and especially in different-sized animals of the same natural group. Its lobes are much thinner at their convex border, opposite the hilus, than elsewhere. The tubes are consequently much shorter there, and I have remarked that the Malpighian tufts are also much smaller. This correspondence between the size of the Malpighian bodies and the length of the tubes, throws much light on the function of the former. A further study of the varieties here displayed in the size of the Malpighian tufts seems highly desirable.

Reflecting on this remarkable structure of the Malpighian bodies, and on their singular connection with the tubes, I was led to speculate on their use. It occurred to me that as the tubes and their plexus of capillaries were probably, for reasons presently to be stated, the parts concerned in the secretion of that portion of the urine to which its characteristic properties are due (the urea, lithic acid, &c.), the Malpighian bodies might be an apparatus destined to separate from the blood the watery portion. This view, on further consideration, appears so consonant with facts, and with analogy, that I shall in a few words state to the Society the reasons that have induced me to adopt it. I am not unaware how obscure are the regions of hypothesis in physiology, and shall be most ready to renounce my opinion, if it be shown to be inconsistent with truth.

In extent of surface, internal structure, and the nature of its vascular network, the membrane of the uriniferous tubes corresponds with that forming the secreting surface of other glands. Hence it seems certain that this membrane is the part specially concerned in eliminating from the blood the peculiar principles found in the urine. To establish this analogy, and the conclusion deduced from it, a few words will suffice. 1. The extent of surface obtained by the involutions of the membrane, will by most be regarded as, itself, sufficient proof. But, 2. Its internal structure is conclusive. Since epithelium has been found by Purkinje and Henle in such enormous quantities on the secreting surface of all true glands, its use cannot be considered doubtful. It never forms less than $\frac{1}{20}$ths of the thickness of the secreting membrane, and in the liver it even seems to compose it entirely, for there I have searched in vain for a basement tissue, like that which supports the epithelium in other glands. As I have endeavoured to show in the forthcoming Number of the Cyclopædia of Anatomy, the epithelium thus chiefly forming the substance of secreting membrane, differs in its general characters from other forms of this structure. Its nucleated particles are never clothed with cilia, and are not surrounded with a definite cell-membrane. They are more bulky, and appear from their refractive properties to contain more substance, their internal texture being very finely mottled, when seen by transmitted light. In these particulars, the epithelium of the kidney-tubes is eminently allied to the best-marked examples of glandular epithelium. 3. The capillary network surrounding the uriniferous tubes is the counterpart of that investing the tubes of the testis, allowance being made for the difference in the capacity of these canals in the two glands. It corresponds with that of all true glands in lying on the deep surface of the secreting membrane, and in its numerous vessels everywhere anastomosing freely with one another.

These several points of identity may seem too obvious to be dwelt upon, but I have detailed them in order to show, that in all these respects, the Malpighian bodies differ from the secreting parts of true glands. 1. The Malpighian bodies comprise but a small part of the inner surface of the kidney, there being but one to each tortuous tube. 2. The epithelium immediately changes its characters, as the tube ex-

pands to embrace the tuft of vessels. From being opake and minutely mottled, it becomes transparent, and assumes a definite outline. From being bald, it becomes covered with cilia (at least in reptiles, and probably in all classes); and, in many cases, it appears to cease entirely, a short way within the neck of the Malpighian capsule. 3. The blood-vessels, instead of being on the deep surface of the membrane, pass through it, and form a tuft on its free surface. Instead of the free anastomosis elsewhere observed, neighbouring tufts never communicate, and even the branchlets of the same tuft remain quite isolated from one another.

Thus the Malpighian bodies are as unlike, as the tubes passing from them are like, the membrane, which, in other glands, secerns its several characteristic products from the blood. To these bodies, therefore, some other and distinct function is with the highest probability to be attributed.

When the Malpighian bodies were considered merely as convoluted vessels without any connection with the uriniferous tubes, no other office could be assigned them, than that of delaying the blood in its course to the capillaries of the tubes, and the object of this it was impossible to ascertain. Now, however, that it is proved that each one is situated at the remotest extremity of a tube, that the tufts of vessels are a distinct system of capillaries inserted into the interior of the tube, surrounded by a capsule, formed by its membrane and closed everywhere except at the orifice of the tube, it is evident that conjectures on their use may be framed with greater plausibility.

The peculiar arrangement of the vessels in the Malpighian tufts is clearly designed to produce a retardation in the flow of the blood through them. And the insertion of the tuft into the extremity of the tube, is a plain indication that this delay is subservient in a direct manner to some part of the secretive process.

It now becomes interesting to inquire, in what respect the secretion of the kidney differs from that of all other glands, that so anomalous an apparatus should be appended to its secerning tubes? The difference seems obviously to lie in the quantity of aqueous particles contained in it; for how peculiar soever to the kidney the proximate principles of the urine may be, they are not more so than those of other glands to the organs which furnish them.

This abundance of water is apparently intended to serve chiefly as a menstruum for the proximate principles and salts which this secretion contains, and which, speaking generally, are far less soluble than those of any other animal product. This is so true, that it is common for healthy urine to deposit some part of its dissolved contents on cooling. It may seem that an exception to this exists in the solid urine of some reptiles; but this expression merely describes the urine as it is found in the cloaca and larger excretory channels. The secretion is brought from the tubules of the gland in a fluid state, and only becomes solid by the re-absorption of its aqueous portion after it has traversed the tortuous canals wherein it was formed, and been placed in a condition to be readily expelled from the system. The subordination of the aqueous part to the purpose of eliminating the more essential elements

of the secretion from the secerning tubules of the gland, is therefore here placed in a clear light.

If this view of the share taken by the water be correct, we must suppose that fluid to be separated either at every point of the secreting surface, along with the proximate principles, as has hitherto been imagined, or else in such a situation that it may at once freely irrigate the whole extent of the secerning membrane. Analogy lends no countenance to the former supposition, while to the latter, the singular position, and all the details of the structure of the Malpighian bodies, give strong credibility.

It would indeed be difficult to conceive a disposition of parts more calculated to favour the escape of water from the blood, than that of the Malpighian body. A large artery breaks up in a very direct manner into a number of minute branches, each of which suddenly opens into an assemblage of vessels of far greater aggregate capacity than itself, and from which there is but one narrow exit. Hence must arise a very abrupt retardation in the velocity of the current of blood. The vessels in which this delay occurs are uncovered by any structure. They lie bare in a cell from which there is but one outlet, the orifice of the tube. This orifice is encircled by cilia, in active motion, directing a current towards the tube. These exquisite organs must not only serve to carry forward the fluid already in the cell, and in which the vascular tuft is bathed, but must tend to remove pressure from the free surface of the vessels, and so to encourage the escape of their more fluid contents. Why is so wonderful an apparatus placed at the extremity of each uriniferous tube, if not to furnish water, to aid in the separation and solution of the urinous products from the epithelium of the tube?

Many recently discovered facts* conspire to prove that secretion is a function very nearly allied to ordinary growth and nutrition; that whereas growth and nutrition comprehend two functions, assimilation of new particles and rejection of old, the old being reconveyed into the blood, so secretion consists in a corresponding assimilation and rejection, and only differs in the old particles being at once thrown off from the system, without re-entering the blood. According to this view, all effete material received into the blood from the old substance of the various organs, must be reassimilated by an organized tissue, specially designed for the purpose, before it can be

* Purkinje, Report of the Meeting of Naturalists at Prague in 1837, Isis, No. 7, 1838. Schwann, Froriep's Notiz. Feb. 1838. Henle, Müller's Archiv. 1838–9. [See also Cyclop. of Anatomy, Art. *Mucous membrane*, the conclusion of which is only just published, although that part of it relating to this theory was written in December last. Mr. Goodsir, since this paper was read, has ably advocated this theory in a communication made to the Royal Society of Edinburgh on the 30th of March, an abstract of which I have just seen in the London and Edinburgh Monthly Journal of Medical Science, May 1842. In the same publication is a report of a paper by the same excellent anatomist, on the structure of the kidney, read at the Med. Chir. Soc. of Edinb. on April the 6th. He describes "a fibro-cellular framework, pervading every part of the gland"—analogous to the capsule of Glisson, and "forming small chambers in the cortical portion, in each of which a single ultimate coil or loop of the uriniferous ducts is lodged." This framework is the structure which I have described (pp. 70–1) as the *matrix*. The convoluted tubes and vessels are all imbedded in it.—*June* 1, 1842.]

eliminated: and all secretions designed for an ulterior use in the œconomy must be assimilated by such a tissue in order to their separation from the blood. This tissue is the epithelium of such surfaces, as, from their external anatomical position, can at once release the secretion, when its elaboration is accomplished. The epidermis of the skin, the epithelium of mucous membranes, and that of true glands, all more or less completely fulfil this purpose; but the first is chiefly designed as a protection, the second partly so, and the third is the only one entirely devoted to what is properly called secretion. Into the examination of this general question, it is impossible that I should now enter, but I shall state some considerations connected with it, that seem to have a bearing on the present subject.

This theory, in its widest sense, supposes the epithelium of secreting surfaces either to pass through constant stages of renovation and decay, or else to remain, during a longer period, as a permanent organic form, assimilating and rejecting, in the mode just described. In many cases the epithelial particles appear to be cast off entire when their growth is complete, and thus to form the secretion; in other instances, they seem to lose their substance by a more gradual process, and to waste or dissolve away on the surface of the membrane, as fresh particles are deposited below; in other examples still, there is reason for believing that they are long a persistent structure. It supposes that the elements of all natural secretions have at one time been a part of an organized form, the epithelial particle; but it leaves it uncertain, whether the secretion, in a complete state, always exists in such particles when alive. It does not determine whether the chemical changes which occur in such particles, issue in the completion of the secreted product, until the period arrives for its being shed from the body. Hence it is beyond the reach of objections founded on the chemical examination of glandular organs *en masse*.

Applying this theory to the kidney, it may be considered highly probable that the epithelium of the uriniferous tubes is continually giving up its effete particles, and undergoing a gradual decay. This view harmonizes in a striking manner with what has been before advanced as to the use of the Malpighian bodies. If the peculiar urinous principles were poured out at once, through the walls of the tubes by the capillaries surrounding them, they must be in a dissolved state from the first, and could need no further aqueous current to carry them off; but if they are deposited in a more or less solid form, as a part of an organized tissue, they will require (being so sparingly soluble) an additional and extraneous source of water, by which, when their formation is complete, they may be taken up and conveyed from the gland. The correspondence before noticed (p. 72) between the size of the Malpighian bodies and the length of the tubes coming from them, is a strong argument in favour of this view.

I stated that the large quantity of water in the urine seemed *chiefly* to serve the purpose of a menstruum. But though this quantity is always large, compared with that in other secretions, it is liable to great variation, according to the state of fulness

of the vascular system, and other circumstances. Hence the kidneys appear to share in the office of regulating the amount of water in the body. How admirably the structure of the Malpighian bodies fits them for thus acting as a self-adjusting valve or sluice to the circulation, I need not explain.

It may possibly be considered by some, that, in the preceding observations on the use of the aqueous element of the urine, and on the nature of secretion in general, I have been endeavouring to illustrate a doubtful hypothesis by speculations more doubtful still, *obscurum per obscurius*. But I rest my view of the function of the Malpighian bodies principally on anatomical grounds, and the other considerations have been introduced in connection with it, rather in consequence of the interest they appear to me to add to it, than because I am fully satisfied of their validity. Undoubtedly both questions are worthy of being separately handled, and require a much wider and more elaborate investigation than seems yet to have been given them. Meanwhile they may in turn receive some elucidation from the researches detailed in this paper. Parallel lines of inquiry into the anatomical varieties of the Malpighian bodies and uriniferous tubes, and into the chemistry of their secretion, in the different tribes of animals and in various stages of their development, could scarcely fail either to confirm or to confute what has now been advanced.

I shall conclude with three remarks founded on the foregoing facts and speculations.

1. The bile and the urine have been ever classed together as the most important excretions. The former is secreted from venous blood; the latter it has been thought from arterial blood, except in some inferior animals, in which the blood from the lower part of the body circulates through the kidneys. But it is a most striking fact, that the proximate principles of the urine, like those of the bile, are secreted *in all animals* from blood which has already passed through one system of capillaries, in a word, from portal blood; although it does not appear to what extent its qualities are changed by traversing the Malpighian system. The analogy is at least remarkable, and may throw some light on the mysterious meaning of the portal circulation.

2. *Diuretic medicines* appear to act specially on the Malpighian bodies; and *various foreign substances*, particularly salts, which, when introduced into the blood, pass off by the urine with great freedom, exude in all probability through this bare system of capillaries. The structure of the Malpighian bodies indicates this, and also, as far as they are known, the laws regulating the transmission of fluids through organized tissues, modified in their affinities by vitality.

3. The escape, also, of certain morbid products, occasionally found in the urine, seems to be from the Malpighian tufts. I allude especially to *sugar*, *albumen*, and *the red particles of the blood*: the two first of which would transude, while the last would escape only by rupture of the vessels*.

* See Note, p. 67.

3 *Norfolk Street, Strand,*
February 14*th*, 1842.

Explanation of the Plate.

PLATE IV.

Fig. 1. Malpighian tuft—Horse. The injection has penetrated only to the capillaries. *a.* The artery. *af.* One of its terminal twigs (or the afferent vessel of the Malpighian body). *d.* The dilatation and mode of breaking up of the terminal twig, after entering the capsule: the division of the tuft into lobes *l*, *l*, *l*, *l*, is well seen. *i*, *i.* Intervals between the lobes. Magnified about eighty diameters.

Fig. 2. Malpighian tuft—Horse. The injection has penetrated through the tuft and has filled the efferent vessel, here coloured yellow for distinctness' sake. *af.* The afferent vessel. *d.* Its dilatation and mode of division. *m*, *m.* Malpighian capillaries. *ef.* Efferent vessel springing from them, and leaving the capsule between two primary branches of the afferent vessel. Magnified about eighty diameters.

Fig. 3. Malpighian body—Horse. The injection, after filling the primary branches of the afferent vessel, has burst into the capsule and passed off along the tube. It has not filled the tuft of capillaries, which consequently are not seen, nor has it spread within the capsule over the whole surface of the tuft. *af.* The afferent vessel. *d.* Its dilatation and mode of subdivision. *c*, *c.* The outline of the distended capsule. *t.* The tube passing from it. *m.* Situation of the uninjected Malpighian tuft. Magnified about seventy diameters.

Fig. 4. From the Horse. The injection has penetrated from the artery, through the Malpighian tuft, into the plexus surrounding the tubes. It has then ruptured the vessels of the tuft, filled the capsule, and passed off along the tube. *a.* Arterial branch. *af.* Afferent vessel. *c.* Capsule distended. *t.* Tube. *ef.* Efferent vessel. *p.* Plexus of capillaries, surrounding other tubes not injected. Magnified about thirty diameters.

Fig. 5. From the Horse. The injection has passed as in the last-described specimen, but without rupture of the Malpighian tuft. *a.* Branch of the artery. *af*, *af.* Afferent vessels. *m*, *m.* Malpighian tufts. *ef*, *ef.* Efferent vessels. *p.* Plexus surrounding the tubes. *st.* Straight tube in cortical substance. *ct.* Convoluted tube in ditto. Magnified about thirty diameters.

Fig. 6. From the Horse. Malpighian tuft, from near the base of one of the medullary cones, injected without extravasation, and showing the efferent vein branching like an artery, as it runs into the medullary cone. *a.* Arterial branch. *af.* The afferent vessel. *m*, *m.* The Malpighian tuft. *ef.* The efferent vessel. *b.* Its branches entering the medullary cone. Magnified about seventy diameters.

Fig. 7. Similar specimens from the Rabbit, but with extravasation into the capsule, and at *t* into the tube also. *af, af.* Afferent vessel. *c, c.* The capsule. *t.* The tube. *ef, ef.* The efferent vessel. *b, b.* Its branches entering the medullary cone. Magnified about thirty diameters.

Fig. 8. From the Horse. Two Malpighian tufts springing close together from a single terminal twig of the artery. An unusual arrangement. *af.* Afferent vessel. *m, m.* Malpighian tufts. Magnified about thirty diameters.

Fig. 9. From the human subject. Two Malpighian bodies injected. The tufts are burst and the fluid has escaped into the capsule. In one case it has passed also along the tube, the extreme tortuosity of which at its commencement, is well seen. *a.* Arterial branch. *af.* Terminal twigs. *c, c.* Malpighian capsules distended. *de.* The depression often seen in such cases, at the point where the afferent and efferent vessels pass: the latter are not here injected. *t.* The tube. Magnified about ninety diameters.

Fig. 10. From the human subject. This specimen has been chosen because it exhibits the termination of a considerable arterial branch, wholly in Malpighian tufts, and because the several Malpighian bodies injected show different appearances of a very instructive kind. *a.* Arterial branch with its terminal twigs. At α the injection has only partially filled the tuft. At β it has entirely filled it, and has also passed out along the efferent vessel *ef*, without any extravasation. At γ it has burst into the capsule and escaped along the tube *t*, but has also filled the efferent vessel *ef*. At δ and ε it has been extravasated and passed along the tube. At *m* and *m* (as in fig. 3) the injection on escaping into the capsule has not spread over the whole tuft. Magnified about forty-five diameters.

Fig. 11. A minute portion of the *surface* of the human kidney, injected from the *artery*. The injection has burst many Malpighian tufts within the cortical substance, and so filled the tubes, the convolutions of which on the surface of the organ are here displayed. It has also traversed other Malpighian tufts without extravasation, and so filled the capillary plexus surrounding the tubes and some radicles of the vein. *t, t.* Tortuous tubes as seen on the surface: these, with their capillaries, cover the surface, so that no Malpighian bodies appear. *p.* Capillary plexus surrounding the tubes, as seen on the surface. *ev.* A branch of one of the stelliform veins. Magnified about forty-five diameters.

Fig. 12. From the Guinea Pig (*Cobaya*). Terminal branch of the renal artery injected. The injection has burst most of the Malpighian tufts and passed off along the tubes. *a.* Arterial branch. At *m* are seen a few Malpighian tufts partially injected without extravasation. Magnified about forty diameters.

Fig. 13. From the Parrot (*Psittacus*). Injected by the artery. *a, a, a.* Terminal branches of the artery. *af, af, af.* Terminal twigs of the artery. *d.* Dila-

tation of the terminal twig on entering the Malpighian capsule. *m*. This dilatation more completely filled, showing its convoluted form, and *ef*. the efferent vessel. *c*. The Malpighian capsule filled, by extravasation from the contained vessel, and the tube *t* likewise filled. *c'*. The same, with the efferent vessel *ef*, also filled. Magnified about eighty diameters.

Fig. 14. From the Boa Constrictor. Injected by the artery. *af*, *af*. Terminal twigs of the artery. *m*, *m*. The convoluted dilated part within the Malpighian capsule. *ef*. The efferent vessel. *c*. The capsule—visible, but not injected. *t*. The commencement of the tube. Magnified about seventy diameters.

[All the preceding figures are viewed by reflected light.]

Fig. 15. From the Frog; viewed by transmitted light. Shows the continuity of the Malpighian capsule with the tube, the change in the character of the epithelium, and the vascular tuft. *bm*, *bm*. Basement membrane of the tube. *ep*, *ep*. Epithelium of the tube. *cav*. Cavity of the tube. *bm'*, *bm'*. Basement membrane of the capsule. *ep'*, *ep'*. Epithelium of the neck of the tube, and of the neighbouring part of the capsule: this epithelium is covered with cilia, which were seen in active motion eight hours after death. *ep''*. Detached epithelial particle, more highly magnified, showing the relative length of the cilia, as they appeared in this specimen. *cav'*. Cavity of the capsule, in which the capillaries, *m*, lie bare, having entered the capsule near *t*, where the view is obscured by another tube. Magnified about 320 diameters.

Fig. 16. *Plan of the renal circulation in Mammalia.* The relative proportions and the character of the several parts are accurately copied from preparations of the *Human* kidney. The artery *a*, (coloured pink) is seen giving a terminal twig *af*, to a Malpighian tuft, *m*, from which emerges the efferent (or portal) vessel *ef* (coloured yellow). Other efferent vessels are seen, *e*, *e*, *e*. All these enter the plexus of capillaries *p* (coloured blue) surrounding the uriniferous tube *t* (coloured red). From this plexus the emulgent vein *e v* springs. Supposed to be magnified about forty diameters.

Fig. 17. *Plan of the renal circulation in animals furnished with a portal vein from an extraneous source.* The colours correspond with those of fig. 16. The relative proportions and position are copied from the kidney of the *Boa* (p. 64), of which a vertical section of one half of a lobe is supposed to be made. *a*. Artery. *af*. Terminal twig going to the Malpighian body. *ef*. Efferent vessel of the Malpighian body emptying itself into a branch of the portal vein *p v* on the surface of the lobe. *b*, *b*. Ultimate branches of the portal vein, entering the capillary plexus *p*, surrounding the uriniferous tube *t*. *u*. Branch of the ureter on the surface of the lobe. *ev*. Emulgent vein within the lobe, receiving the blood from the plexus surrounding the uriniferous tubes. Supposed to be magnified about forty diameters.

V. *On the Chemical Analysis of the Contents of the Thoracic Duct in the Human Subject.* *By* G. Owen Rees, *M.D., F.G.S., Physician to the Northern Dispensary.* *Communicated by* P. M. Roget, *M.D., Sec. R.S., &c.*

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THE contents of the thoracic duct in the human subject having never been obtained in sufficient quantity for the purposes of chemical analysis, I resolved to avail myself of an opportunity which lately presented itself in the execution of a criminal at the Old Bailey.

Through the kindness of Messrs. Macmurdo and Holding, the medical officers of Newgate, and with the assistance of my friends Mr. Hilton and Mr. Samuel Lane, I was enabled to commence operating upon the body one hour and a quarter after death, and before it had become cold, although the thermometer stood considerably below 32° Fahr., and the body had been exposed on the scaffold during one hour. The subject was muscular and of the middle height, and the prisoner had not become emaciated during his confinement in jail. On the evening preceding his execution, he had partaken of some supper, consisting of about 2 oz. of bread and 4 oz. of meat; and the next morning, he drank two cups of tea, and ate a piece of toast made from the quarter of a round of a quartern loaf, and about a quarter of an inch in thickness. This breakfast was taken at seven o'clock A.M., one hour before death. He swallowed a glass of wine just before mounting the scaffold.

The contents of the posterior mediastinum having been previously included in a ligature from the left side, the thoracic duct was reached without much difficulty by raising the right lung, and dividing the pleura which forms the right boundary of the posterior mediastinum. The duct was easily found, being distended with chyle: it was seized immediately below the point at which it was intended to divide it. The operator detached it as much as possible from its cellular connexions, and holding it between the thumb and finger, it was divided while thus compressed. The fingers and lower part of the duct were then well washed by pouring clean water over them in order to be certain that no serous secretion or blood might become mixed with the chyle. The divided extremity of the duct was next placed in a perfectly clean glass bottle, into which its liquor flowed freely; its motion being facilitated by gently kneading the abdominal contents. In this manner nearly six fluid drachms of chyle were obtained, the physical characters of which were as follows:—It was of a milky hue, with a slight tinge of buff. Its consistence was much the same as that of milk. The latter portion which was obtained (four drachms being received in a first, and

two drachms in a second bottle) coagulated on becoming cold; but the portion received in the first bottle being retained in the hand of Mr. Holding, and thus kept at a higher temperature, did not coagulate during a full hour; and on subsequently being allowed to cool to the same extent as the specimen obtained in the other bottle, it still remained perfectly fluid. The coagulation which took place in the other specimen was however very slight; and a partial resolution of the clot occurred after a few hours had elapsed*. The specific gravity of this fluid was 1·024. Chemical examination yielded the following results.

When fresh, it was neutral in its reaction on test papers; a portion, however, which was kept some days, became slightly acid during decomposition.

The application of heat coagulated it strongly. The addition of nitric acid also produced a strong curd.

Acetic acid did not coagulate it, but, on the contrary, rendered it somewhat more pellucid. The addition of acetic acid and the subsequent addition of a solution of ferrocyanuret of potassium produced a strong white flocculent precipitate. A portion of the fluid was next submitted to analysis in the following manner.

The proportion of water was ascertained by careful evaporation over a water-bath until no decrease of weight was observed by further application of heat; the loss indicated the weight of the water. The solid extract obtained was finely powdered, digested with ether for a day in a closed vessel, and then again similarly treated with a second portion of the menstruum; lastly it was washed with ether. The ethereal solutions thus obtained were mixed together and evaporated; the solid residue was estimated as fatty matter. The portion insoluble in ether was next treated with boiling distilled water, and allowed to digest at a temperature of about 57° Fahr. for twelve hours. It was then again similarly treated, care being taken to pour off the first digested portion of water as nearly as possible without disturbing the deposit, before adding the second quantity. The solid matter was then placed on a filter washed with distilled water, dried and weighed as albumen. The filtered liquors and washings were collected and evaporated together, and the dry result treated with successive portions of alcohol, of the specific gravity 0·832, until everything soluble in that menstruum was dissolved out. The insoluble portion was then dried and weighed as "animal extractive matter and salts soluble in water only;" and the alcoholic solutions being evaporated, their extract was estimated as "animal extractive matter soluble in water and alcohol." The salts were obtained from these extractives by incineration and carefully conducted decarbonization; and their weights being subtracted from that of their respective extractives, the difference gave the true weight of the animal extractive matter with which they had been combined. The quantitative analysis, conducted as above, yielded the following result in 100 parts:—

* The fibrin of the lymph and chyle of the Ass coagulate with sufficient strength to admit of separation and estimation in analysis.

Water	90·48
Albumen with traces of fibrinous matter	7·08
Aqueous extractive	0·56
Alcoholic extractive, or Osmazome	0·52
Alkaline chloride, carbonate, and sulphate, with traces of alkaline phosphate and oxide of iron	0·44
Fatty matters	0·92

The fatty matters extracted in this analysis possessed, for the most part, the same characters as those of the blood, being separable by boiling in alcohol, and subsequent cooling, into a crystalline fat, which was deposited as the alcohol became cool, and an oily matter which was completely soluble in cold alcohol; these fats differed, however, from those of the blood in not containing phosphorus, which was proved by their yielding an alkaline, instead of an acid ash on incineration. The albuminous matter was not of the dead white colour observed in that obtained from pure chyle, owing, doubtless, to the contents of the thoracic duct containing a considerable proportion of lymph. On incinerating this albumen, an ash was obtained, containing phosphate of lime and traces of oxide of iron. The whole of the spontaneously coagulable albumen or fibrin*, which presented itself as clot in part of this chyle, is estimated as albuminous matter in this analysis, as it was found quite impossible to separate it without considerable loss, and the coagulum was very slight and broke down very rapidly.

The aqueous and alcoholic extractives mentioned in this analysis agreed in most respects in chemical characters with those obtained from the blood, with the exception that the aqueous extractive yielded a ferruginous ash, which is never the case with that principle as procured from the blood. I have ascertained by experiment that pure chyle obtained from the lacteals of the Ass yields an aqueous extractive containing iron; it is, therefore, to the chyle and not to the lymph that we owe this property of the aqueous extractive. The salts, obtained by incineration from the alcoholic extractive, yielded a larger proportion of alkaline carbonate than is obtained from the blood, indicating a larger proportion of an alkaline lactate in the contents of the thoracic duct. I have alluded to the dead white colour of the albuminous matter obtained from pure chyle, and stated that the admixture of lymph in the contents of the thoracic duct interfered with its developement in the albumen obtained from the fluid the examination of which I have detailed. Some months ago I had an opportunity of tracing this effect to its true cause, namely the presence, in the chyle, of an opake white organic matter identical with a substance existing as a constituent of the saliva, and which appears to act an important part in the process of nutrition. I have obtained this animal substance on a former occasion in consider-

* I have thought it right to apply to fibrin the term spontaneously coagulable albumen, the recent observations of Liebig and others having shown it to be chemically identical with albumen.

able quantity from the chyle of the Ass, and found it to exhibit peculiar characters, which I have described in the Medical Gazette for January 1, 1841, to which I may refer also for a comparative analysis of the chyle and lymph of this vegetable feeder. It has frequently been stated by observers, that chyle, when set aside to coagulate, assumes a pink colour if exposed to the air; this is stated to be the case by MÜLLER in the chyle from the thoracic duct of the Horse. My own observations do not agree with this statement; for fluid taken from the thoracic duct of the Dog, Ass, and Cat, as also that lately obtained from the human subject, showed no such change of colour when under the conditions mentioned by MÜLLER. There were, indeed, a few blood-corpuscles to be seen by microscopic examination; but these were so few in number and so divided as not to manifest their colour, and were, I have no doubt, taken up by the divided mouths of some of the absorbents which emptied themselves into the thoracic duct during the period occupied by us in obtaining its contents. Mr. SAMUEL LANE was, I believe, the first observer who traced the existence of the blood-corpuscle in the chyle to its true cause, and showed that chyle might be procured free from such contamination, if the contents of the thoracic duct were speedily obtained. I have had occasion in this analysis to verify my former views concerning the cause of the white colour of the chyle, which I feel confident is chiefly attributable to its containing the opake white salivary matter as a constituent. This substance is always, however, mixed with a certain proportion of fatty matter. It may be obtained from chyle by agitation with ether; when we find it to subside through the ether, and to float on the surface of the chyle which has now become cleared.

The microscopic examination of human chyle has been much neglected. From the appearances observed in the specimen lately obtained, I am enabled to state that its corpuscles are of the same description as those in the chyle of purely animal and vegetable feeders. They consist of two classes, viz.—1. Larger spheroidal bodies, varying in size, but for the most part larger than the blood-corpuscles, semitransparent, and granular on the surface. The largest of these corpuscles are nearly twice the diameter of those of the blood. 2. Minute granules varying in size from about $\frac{1}{10}$th the diameter of the blood-corpuscle to a size which scarcely admits of their being seen, except by the aid of a perfect light and a microscope capable of magnifying to about 750 diameters, when they appear to form a kind of back-ground on which are seen the larger corpuscles first noticed. These granules have been described by Messrs. LANE and GULLIVER as existing in the chyle of animals. Mr. LANE has likewise described a molecular motion in them, which I have had occasion to verify. Besides these corpuscles and granules we also detect fatty globules in the chyle, varying greatly in size. If we compare the analysis I have given of the contents of the thoracic duct with the analysis of the blood, we cannot fail to be struck with the very great excess of fatty matter existing in the former. We have a large quantity of an hydrocarbonous ingredient constantly entering the blood, and becoming consumed with great rapidity, as proved by the small percentage

of fatty matter contained in the mass of blood. Whether this hydrocarbonous matter is exhaled by the lungs and skin in the form of water and carbonic acid, or whether, on the contrary, an absorption of nitrogen and oxygen occurs in the process of respiration, so as to convert the fat of the chyle into albuminous matters for the purposes of secretion and nutrition, is not yet determined; many circumstances, however, seem to favour the latter view; thus, the chyle of an animal fed on beans and oats, substances very different in quality from fatty matters, is found to contain a very large proportion of fat, destined, no doubt, for some useful purpose of the animal economy, and which would scarcely be produced from aliment in order to be subjected to a direct process of excretion. The proportion of "extractive matter soluble in water and alcohol" or osmazome, will be found greatly to exceed the amount of that principle contained in the blood; agreeing well with what we know concerning the universal distribution of this substance as a constituent of the soft parts of the human frame.

VI. *Report of a remarkable appearance of the Aurora Borealis below the Clouds.* *By the Rev.* James Farquharson, *LL.D., F.R.S., Minister of the Parish of Alford.*

Received March 17,—Read April 14, 1842.

Alford, February 24, 1842.—Saw, at 11 P.M., a remarkable aurora borealis, between the observer and lofty stratus clouds. The density of the clouds, the great brilliancy of the meteor, its considerable continuance, its renewed display, and the extent of space it occupied, left no doubt of the reality of the phenomenon.

After a day, during which the whole heavens had been mostly shrouded by a uniform cloud, with a gentle wind at N.W., the sky, after sunset, became partially clear; and the thermometer descended to 34°, with calm. Barometer 28·89 inches. At 11 P.M. a very brilliant display of pencils of aurora (streamers) was seen at W. by S., in a limited space about 10° broad, and 15° or 20° high, a little above the visible horizon; and a separated display of the same, much wider, and of nearly the same height, but not quite so brilliant, in another limited space at N.W. It was instantly seen that in both spaces the bright meteor was between the eye and lofty stratus clouds. These clouds extended in long parallel belts, some of them 10° or 15° broad, some broader, with narrow intervals of clear sky between them, in a direction from N.W. to S.E. This arrangement was clearly seen in all the western part of the sky, although there existed under these clouds thinner fleecy irregular ones, which here and there obscured it for short distances. These lower irregular clouds prevailed more in the eastern part of the sky; but there, also, the arrangement of the belts of stratus was recognised through their intervals. One of the irregular thin clouds lay over the moon, then nearly south, and nearly at full; and its consistency was such as to obscure the dark spaces on her disc, although not its circular outline. The lofty stratus clouds, were, in some parts at least, of much denser consistency; as was proved by their totally obscuring some very brilliant falling stars, which passed behind them, as will be afterwards described.

The exhibition of pencils of aurora at the W. by S. space was of unusual brilliancy, and the coruscations incessant, as they brightened up, and faded, and suddenly disappeared, and were renewed, successively. The colour at the lower extremity was a lively minium red, but only for a short way up; the upper part being of the common greenish yellow. They crossed, angularly, the lofty cloud nearest to the western horizon, which was narrow, and were clearly seen upon its face, and stretching their extremities into the clear sky on each side of it. Even the feeblest of them maintained its continuity and its peculiar tinge of colour, over both the thinner

edges, and denser middle part of the stratus. About five minutes after it was first seen, this aurora became extinct; but in the course of three or four minutes was suddenly renewed, with a slight shift to the southward, in as great or even greater brilliancy. In the mean time, the aurora at the N.W. space exhibited like appearances, and colours; red at the lower extremities of the brilliant pencils, and greenish yellow upwards. The space here occupied by the pencils, or streamers, was much broader, and the lights less condensed into one place, disappearing in some compartments and extending to others alternately. They played over several belts of the stratus clouds, and intervening clear spaces of sky; and were seen, without diminution of lustre or change of tinge, on the face of the former. At both sides of this space, there were some of the thin irregular lower clouds, behind which some of the pencils passed, sometimes at one or other of their extremities, sometimes at their middle part. In such cases their continuity instantly disappeared; for although the light of the more brilliant ones shone through these clouds, it was only in a white nebulous form, without any parallelism of rays, as seen in the pencils when not so obscured.

About twenty minutes after the aurora was first seen, dense clouds with curled edges were rather quickly formed over both the spaces occupied by it, of larger extent than they were; and although the observations were continued till half-past twelve o'clock, the meteor was not again seen in the same spaces; but about a quarter to twelve o'clock, a comparatively small space of bright nebulous aurora, without defined pencils, was seen very near the horizon at W.N.W. That too disappeared; and in the mean time the clouds in all parts of the sky by degrees dissolved; the lofty stratus ones more slowly than the others. At half-past twelve o'clock, only a few remained at the S.E., when the observations were discontinued.

During the continuance of the aurora, two bright shooting stars descended above the space at N.W., in paths parallel to the streamers, that is to the dipping-needle. They were of slow motion, and became invisible when passing over the belts of stratus clouds, but emerged again after passing them. At a quarter to twelve o'clock, a shooting star, as large as Venus at her greatest elongation, shot from near the zenith a little to the eastward of the magnetic meridian, and descended in a path parallel to that circle, disappearing while passing behind some stratus clouds, but not quite while doing so behind some low irregular ones, that lay in its course. Its motion was slow, and fitfully interrupted.

February 25th.—Clear sky in the morning. Unusually abundant spiculæ of hoar frost over all the ground, and whitening the hills to their summits, like a shower of snow. Register thermometer through the night at 29°.

VII. *On Fibre.* *By* Martin Barry, *M.D., F.R.SS. L. and E.*

Received December 3,—Read December 16, 1841.

THERE is scarcely any term so generally used in the description of animal or vegetable tissue, as the term *fibre*. If this serves to show the universal presence of fibre, it also indicates the importance of having a correct notion of its structure. On this subject, however, physiologists differ widely: some believing fibre to be composed of globules, while others maintain that no globules can be discerned in it.

My investigations have led me to adopt neither of these views. Should the observations that I have to communicate be found deserving of attention, it will be owing to my having carefully examined the structure of fibre in the course of its formation, beginning with the very earliest stage. At this period, I had to deal with an object of considerable size; the form of which, therefore, could be distinctly seen: and by tracing the metamorphoses of the large and parent fibre, I was enabled to see in the minute succeeding ones a structure, which I think would not otherwise have been discerned. We may hereafter see the cause of the difference in opinion regarding the structure of fibre.

The present memoir, though devoted to the investigation of fibre, is in fact a continuation of those which I have already communicated to the Society on the Corpuscles of the Blood†.

Formation of a Flat Filament within the Blood-corpuscle.—Structure of this Filament.—Presence of a Filament having the same appearance in the Coagulum of Blood; as well as in the Tissues generally, of both Animals and Plants.—This Flat Filament is what is usually termed a "Fibre."

1. In the mature blood-corpuscle (red blood-disc), there is often to be seen a flat filament or band already formed within the corpuscle. In Mammalia, including Man (Plate V. figs. 4, 1, 2), this filament is frequently annular; sometimes the ring is divided at a certain part; and sometimes one extremity overlaps the other. In Birds (fig. 5.), Amphibia (figs. 8, 9, 10, 11), and Fishes (figs. 12, 13), the filament is of such length as to be coiled.

2. This filament is formed of the discs contained within the blood-corpuscle. In Mammals, the discs entering into its formation are so few as to form a single ring; whence the biconcave form of the corpuscle in this class, and the often annular form

† Part I. Philosophical Transactions, 1840, p. 595, Part II. Philosophical Transactions, 1841, p. 201, Part III. Philosophical Transactions, 1841, p. 217.

of the filament it produces. In the other Vertebrata, the discs contained within the blood-corpuscle are too numerous† for such a ring; therefore their arrangement forms a coil. At the outer part of this coil, the filament (already stated to be flat) is often on its edge (figs. 10, 11, 12), from which arises a greater thickness of the corpuscle, and the appearance it has of being cut off abruptly at this part; while in the centre, there is generally the unappropriated portion of a nucleus (figs. 8, 10): whence the central eminence, around which there appears a depression in those corpuscles that, from the above cause, have the edge thickened.

3. The nucleus of the blood-corpuscle in some instances resembles a ball of twine, being actually composed, at its outer part, of a coiled filament (fig. 10 β, γ).

4. Such of the Invertebrata as I have examined (figs. 14, 15), likewise present the blood-corpuscle passing into a coil.

5. Acetic acid dissolves the part most advanced, leaving the newest part behind. This accounts for the figures accompanying my Part II. on the Corpuscles of the Blood‡, representing corpuscles of Birds, Amphibia, and Fishes, from which the filament in question, or its elements, had been removed by this reagent.

6. The filament thus formed within the blood-corpuscle, has a structure which is very remarkable (see the figures just referred to). It is not only flat, but deeply grooved on both surfaces; being thereby thinner in the middle than at the edges. The edges are rounded: and when seen on its edge, the filament at first sight seems to consist of segments. It is important, however, to observe, that the line separating the apparent segments from one another, is not directly transverse, but oblique (see fig. 9 γ).

7. Of course the structure of an object so minute, cannot be seen without a very high magnifying power, and a good light. And it may be here remarked, that in the researches forming the subject of this paper, I have generally added dilute spirit (sp. gr. about 0·940), containing about $\frac{1}{200}$th of corrosive sublimate§.

8. It is deserving of notice,—in the first place, that portions of the coagulum of blood sometimes consist of filaments having a structure identical with that of the filament formed within the blood-corpuscle; secondly, that, in the coagulum, I have noticed the ring formed in the blood-corpuscle of Man (fig. 4), and the coil formed in that of Birds (fig. 6) and Reptiles, unwinding themselves into the straight and often parallel filaments of the coagulum,—changes which may be also seen taking place in blood placed under the microscope before its coagulation; thirdly, that I have noticed similar coils strewn through the field of view (figs. 7, 17), when examining various tissues,—the coils here also appearing to be altered blood-corpuscles, and

† Philosophical Transactions, 1841, Pl. XVIII. figs. 52 γ, 54 ϵ. In all vertebrated animals the *young* blood-corpuscle is a mere disc, with a depression in the centre. In Mammalia it continues of this form; while in the other Vertebrata it becomes a nucleated cell.

‡ *L. c.*, Pl. XVIII.

§ For the examination of certain tissues, especially muscle, I have since used chromic acid—sp. gr. about 1·050.

unwinding; lastly, that filaments having the same structure as the foregoing, are to be met with apparently in every tissue of the body.

9. I proceed to enumerate the parts in which I have observed the same kind of filaments; without stopping to point out peculiarities in their size or in their mode of combination in the various parts. Future observers will find, that while in some parts they have coalesced to produce a membrane, have themselves passed into tubes, or are otherwise rendered indistinct, they retain their form remarkably, being sometimes crossed in various directions, or at other times lying parallel. Some remarks on this subject will be found in the explanation of the figures, as for instance in that of the cornea (fig. 91). The parts in which I have noticed the filaments in question are these: the cortical and medullary substance of both the cerebrum and cerebellum, the spinal chord, the optic nerve and retina, the olfactory and auditory nerves, nerves connected with the spinal chord, voluntary and involuntary muscle, (the latter including the muscle in all parts of the alimentary canal, and the Fallopian tube and uterus, as well as blood-vessels, the iris and the heart), tendon, elastic tissue, cellular and fatty tissue, serous membranes (peritoneum, pericardium, and arachnoid membrane), various parts of the so-called mucous membrane†, the lining membrane of the large blood-vessels and the valve of a large vein, the skin, the dura mater and the sheath of the spinal chord, ligament, the gums and palate, the stroma of the ovary, the testis and the walls of the vas deferens, the kidney and ureter, the glans, as well as the corpus spongiosum and corpus cavernosum penis, the coats of the gall-bladder and of the cystic duct, the pancreas, the liver. I found them along with the marrow from a bone; between the rings of the trachea, as well as in the substance of the lungs, and the gills of the common Mussel; in the parenchyma of the spleen, the lachrymal gland, the sclerotic coat of the eye, the conjunctiva, the cornea, the membrane of the vitreous humour, the capsule of the crystalline lens, the lens itself, the cartilage of the ear and cartilage of bone, bone itself, the periosteum, the claw of the Bird, the shell-membrane of the egg, substance connecting the ova of the Crab, silk, hair, the incipient feather, the feather-like objects from the wing of the Butterfly and Gnat, and the Spider's web. These are the principal of the animal structures in which I have found filaments such as those above described.

10. Of plants, I subjected to microscopic examination the root, stem, leaf-stalk and leaf, besides the several parts of the flower: and in no instance where a fibrous tissue existed, did I fail to find filaments of the same kind. This was in the Phanerogamia. On subsequently examining portions indiscriminately taken from Ferns, Mosses, Fungi, Lichens, and several of the marine Algæ, I met with an equally general distribution of the same kind of filaments.

11. The flat filament seen by me in all these structures, of both animals and

† I saw a curious interlacement of these filaments on the villi of the lining membrane of the rectum in the Rabbit.

plants, is that usually denominated a "fibre." And the appearance of the filament in all the structures mentioned, was essentially such as that delineated in the figures above referred to: an appearance which I have never before seen represented as that of "fibre."

12. Most of the figures which accompany the memoir present filaments, having the appearance in question. It will be seen to be precisely such as that of the filament formed within the corpuscle of the blood. We know that discoid corpuscles circulate in plants; and it remains to be seen whether filaments are not formed in these.

The foregoing facts, I think, indicate the necessity in physiological research, of not resting satisfied with mere opinion, though emanating from so high an authority as HUNTER; who supposed the corpuscles to be "the least important portion of the blood."

Structure of the Flat Filament ("Fibre") more particularly investigated.

13. We have hitherto viewed the object called by me a flat filament, only in some of its minutest forms. These are sufficient to show that it is a compound structure. But in order to become more particularly acquainted with this structure, it is requisite to trace the filament into similar objects of larger size. For this purpose, it will be sufficient to examine *successively* the following figures, from nervous substance, from muscle, and from the crystalline lens: namely, figs. 117 β, 116 β, 115 β, 114 β, 62, 53, 92, 56, 54, 84, 131.

14. I have attempted in fig. 55. to represent what has appeared to me to be the structure of the objects in the figures now referred to. Here (in fig. 55) we find two spirals, running in opposite directions, and interlacing at a certain point (α), in every wind. This arrangement gives to the entire object a grooved appearance and a flattened form. It is in fact the structure which, for want of a better term, I have called a flat filament. The edge of this filament (figs. 114 β, 56 γ, 62) presents what at first sight seem like segments, but which in reality are the consecutive curves of a spiral thread. A transverse section of such an object is rudely represented by the figure 8. This is precisely the appearance presented also by the minutest filament or "fibre:" and I particularly refer to the oblique direction of the line separating the apparent segments in the smaller filament (fig. 9 γ), in connection with the oblique direction of the spaces between the curves of the spiral threads in the larger one.

15. In further proof of identity in the structure of the larger and the smaller filaments, it may be mentioned that I have seen filaments of minute size to enlarge, and give origin in their interior to other filaments (fig. 131).

16. We shall hereafter find that there is a tendency in these filaments to become membranous at the surface (par. 62). Hence it appears to be, that, very often when the flattened form of the filament and its grooved middle part are distinctly visible, no trace whatever of a crenate edge can be discerned. This may serve to show the necessity for extended observation, before investigators come to a conclusion as to

the existence of filaments, such as those I have described. And here they should be apprized, that the filaments are sometimes exceedingly minute. Such was their condition, for instance, in tendon. In bone also, from which the phosphate of lime had been removed (by muriatic acid), I found them exceedingly minute. The varying appearance of the edges of the filament, just referred to, may assist to explain why some have believed "fibre" to consist of globules; while others have maintained that no globules can be discerned in it.

The Spiral Form as general in Animals as in Plants—Universality—and Early Appearance of the Spiral Form.

17. It is known that vegetable tissue presents, in some parts, a feature which has heretofore seemed wanting, or nearly so, in that of animals—the *spiral* form. I venture to believe that some appearances met with in my investigations may go far towards supplying this deficiency. These appearances will be found represented in the nervous tissue (Plates VI., VIII., IX.), in muscle (Plates VI., VII., VIII., IX.), in minute blood-vessels (fig. 16), and in the crystalline lens (fig. 131). If indeed the view above mentioned—that the larger and the smaller filaments have the same structure—be correct, it follows that spirals are much more general in plants themselves than has been hitherto supposed. Spirals would thus appear, in fact, to be as universal as a "fibrous" structure.

18. The tendency to the spiral form manifests itself very early. Of this the most important instance is afforded by the corpuscle of the blood, as above described. I have also obtained an interesting proof of it in cartilage from the ear of a rabbit (figs. 133 to 136), where the nucleus, lying loose in its cell, resembled a ball of twine; being actually composed, at its outer part, like the nuclei of certain blood-corpuscles, of a coiled filament; which it was giving off to weave the cell-wall; this cell-wall being no other than the last formed portion of what is termed the intercellular substance—the essential part of cartilage.

19. I think there is ground for believing, that the nucleus of the cell in cartilage, now compared to a ball of twine, is descended by fissiparous generation from the nucleus of the blood-corpuscle; which on a former occasion† we saw to give the first origin to cartilage, for I have never seen the nucleus of a cell arise, except as part of a previously existing nucleus‡. It is therefore interesting now to find in each the appearance which I have compared to a ball of twine: though it is not likely that cartilage is the only tissue to which the blood-corpuscle transmits the property in question.

Mode of Origin of the Flat Filament ("Fibre")—Its Reproduction.

20. It is known that, in order to the formation of certain fibrous tissues, cells

† Philosophical Transactions, 1841, Pl. XXII. figs. 116½—122.

‡ Some of the nuclei in the cells of cartilage in figs. 134, 135, were apparently undergoing division.

apply themselves to one another (fig. 28), so as to present the appearance of a necklace; and that subsequently, as the partitions between the cell-cavities are absorbed, this necklace becomes a tube. It is supposed that the ultimate threads of the tissue arise within this tube. But on the subject of the particular mode of origin of these ultimate threads, I am not aware that we possess any published information, except that furnished by Schwann and Valentin: the former having shown that a "secondary deposit" makes its appearance on the inner surface of the wall of the tube†, and the latter, that this deposit soon presents longitudinal threads; which threads have sometimes the appearance of being "composed of longitudinal rows of globules‡." I do not find that any mention has hitherto been made of a *second* order of tubes, arising within the first or parent tube (par. 42). The results obtained by myself are by no means complete; but may perhaps afford information that will serve as a guide in future investigations.

21. Cells applied to one another in the above necklace-like manner, I formerly showed to become filled with discs§. If now fig. 26 γ be referred to, such discs—or cells into which the discs have passed—will be seen arranged in lines, corresponding with the direction of the forming tube. This figure was taken from the mould of cheese. Fig. 36 presents an arrangement of the same kind, noticed in voluntary muscle.

22. One of the purposes for which this linear direction occurs, seems to be the production of smaller tubes within the larger one (fig. 30); and another purpose is apparently a peculiar arrangement of discs within the smaller tube. Such an arrangement is seen in figs. 45 to 48. In some of these, the discs had become rings. The structure of these rings was such as to leave no doubt with me, that the same process was in operation as that producing the changes, above described, in corpuscles of the blood. The blood-corpuscle (fig. 17 α) passes from a mere disc into a ring (β, γ), and this ring into a coil (δ, ε, ε). Now, with the regular arrangement of rings seen at α fig. 48, and with the analogy of the blood-corpuscles just mentioned, it seems highly probable that every ring (fig. 48 α) becomes a coil, and that the extremities of coils in the same line unite, to form a spiral. I have to add, that a spiral (γ) actually existed in this tube (fig. 48) in a line with the rings represented in the figure, having obviously been formed out of such rings: and I know of no way in which the transformation could have been effected so easily and so naturally as that now described.

23. The tube in question (fig. 48) presents, not merely one, but *two* spirals: and these two spirals interlace with one another. This interlacement seems to explain

† Schwann, "Mikroskopische Untersuchungen über die Uebereinstimmung in der Struktur und dem Wachsthum der Thiere und Pflanzen." Tab. IV. fig. 3.

‡ Valentin, in Müller's Archiv, 1840, p. 204. My observations are entirely different from those of Valentin as to the office performed by the nucleus of the cell.

§ "On the Corpuscles of the Blood," Part III., *l. c.*, par. 161.

the remarkable arrangement of the two lines of rings at α. For, during the transition (as I suppose) of the rings into coils, an interlacement is almost a necessary consequence of the alternate succession of the rings. I have also seen this interlacement of spirals provided for, apparently, by the rings of several lines being linked together while still rings (fig. 47: see also fig. 120).

24. Figure 48, from its exhibiting only one side of the tube, represents but two rows of rings. The number of rows, however, contained in the tube seemed four: which of course would become connected in the above way, as easily as two; and give origin to a corresponding number of interlacing spirals.

25. I cannot suppose that minuteness is any hindrance to the smallest filament ("fibre") having its origin *by the same mode: and to this, the linear arrangement of the discs within the blood-corpuscle seems to have especial reference*†. Facts will be hereafter mentioned, which seem to show a *fasciculus* of filaments to be thus produced in a certain tissue (par. 42—44).

26. Within the windings of the spirals (fig. 57 α), nuclei are sometimes to be discerned. It appears to be from these nuclei that there proceeds the substance for forming new filaments (fig. 22); which are very often seen within the winds of spirals (figs. 131 β, 94, 58).

27. I have in some instances observed the filaments, when enlarging, to present a remarkable change in the relative position of their spiral threads. If figs. 40, 41 be referred to, it will be seen that α of fig. 40 passes into α of fig. 41, and the latter into β of the same figure. The scheme fig. 60 may illustrate this transition. This scheme is merely an altered state of that in fig. 55. In each there are two spirals; the difference consisting in the relative position of the spirals. The points in contact at α fig. 55, have separated in fig. 60 (α, α); so that now, a transverse section is no longer represented by the figure 8 (par. 14), but by a circle. This latter (fig. 60) seems to exhibit the relative position of the spirals, in some instances, when they begin to form, as will be hereafter shown, the membrane of a tube. Such appears to be their state in fig. 41. β: a state which apparently precedes the formation of the tubes in figs. 42, 43, and the subsequent figures in this Plate.

Facts observed in the Formation and Structure of Nerve.

28. It is known that in the so-called "primitive fibres" into which a nerve can be separated by means of needles, Remak demonstrated a "band-like axis‡," corresponding to the "cylindrical axis of Purkinje‡;" and that the substance surrounding this axis, has been termed by Schwann, the "white substance of the nervous fibre‡." This "white substance" I find to consist of filaments (fig. 112 α, β—fig.

† See my Part III. on the Corpuscles of the Blood, Philosophical Transactions, 1841, Plate XVIII. figs. 52 γ, 54 ε.

‡ Müller's Elements of Physiology, translated by Dr. Baly, Part VI. p. 1649.

102 α, β, γ), having the same structure as those constantly referred to in the present memoir. These filaments, forming the white substance of the nervous fibre, are often seen to be curiously interlaced (fig. 102 γ), as though each filament had a spiral form. In other instances their direction is more longitudinal (fig. 112 α).

29. Professor MÜLLER justly says, "The great size of the so-named primitive fibres of the nerves, as compared with the minute elementary parts of muscles, the cellular and other tissues, excites a doubt as to whether the fibre contained in the nervous cylinder is really its most minute element†." He states that "in fibres of the thickness of the ordinary primitive fibres, which SCHWANN examined in the mesentery of the Frog, he saw other much finer filaments which issued from the larger fibre‡." To the filaments seen by SCHWANN, I shall refer in a future page. MÜLLER adds, that "TREVIRANUS observed in several nervous cylinders streaks running longitudinally, and he even saw distinctly more minute elementary filaments in the so-called primitive cylinders§."

30. The filaments noticed by TREVIRANUS, I think may have been the flat filaments in question. But these flat filaments, as we have seen, have themselves a compound structure.

31. It is very common to find the nerve-cylinder ("primitive fibre") drawn out to a point from manipulation, like the fasciculus of muscle. See remarks on the alteration of the spirals in the muscular fasciculus, and on the office performed by the investing membrane, in this change (par. 54).

32. The filaments in fasciculi from the optic (fig. 107), olfactory (fig. 108), and auditory nerves, have appeared less tense than those in the common spinal nerves; and there has been a less decided appearance of membrane at the surface in the former.

33. In examining the substance of these soft nerves, as well as that of the brain and spinal chord, I have employed for the most part such as had been preserved in spirit: and, besides using extremely minute portions, I have very often found it needful to avoid adding any covering whatever; the weight of thin mica itself being sufficient to rupture or to flatten it, and thus entirely prevent the structure from being seen. I have already stated it to have been my general practice in these examinations, to add corrosive sublimate dissolved in dilute spirit (par. 7).

34. In the substance of the brain and spinal chord, I have usually met with a very large number of discs (fig. 17 α, β), which from their colour, size, and general appearance (corresponding in these respects with many of the corpuscles within the blood-vessels of the pia mater), seemed to be young corpuscles of the blood. Along with these were rings (γ) and coils of filaments (δ, ε, ε), into which the discs appeared to pass. I have noticed similar rings in the auditory and optic nerves; and coils, as well as rings, in the retina (fig. 18), these coils being of the colour of the blood-corpuscle. Sometimes the coils (fig. 21) are very thick, and comparable to coils of rope.

† Elements of Physiology, translated by Dr. BALY, Part III. p. 597.
‡ Ibid. pp. 597, 598. § Ibid. p. 598.

35. The constant presence in these parts, of discs, rings, and coils, makes it difficult to avoid connecting them with such objects as that in fig. 22: the outer spiral in which, for instance, may represent an advanced state of coils like those in fig. 21. Spirals were present between α and β in fig. 22; but they have not been delineated.

36. In fig. 80 γ, is a broad band-like axis, consisting of delicate longitudinal filaments, and having filaments (β) external to it; these being surrounded by a spiral (α). The broad band-like axis (γ), I think may correspond to that of REMAK above referred to; the "white substance" of SCHWANN being here represented by the filaments β and α. If, however, this analogy exists, my observations go farther even than REMAK's. The axis described by this observer was found by him to be susceptible of division into filaments. So also is the one described by myself (fig. 80 γ, 81 β, 85 β). But what I add is that each filament is a compound body, that enlarges (fig. 86), and, from analogy, may contain the elements of future structures, formed by division and subdivision to which no limits can be assigned.

37. The filaments β in fig. 85, being of far minuter size than the so-called "primitive fibre" of the nerves (figs. 102, 112 α, β), I think it possible that the filaments referred to in a former page, as seen by SCHWANN to proceed from one of the ordinary "primitive fibres" in the mesentery of the Frog, may have had a similar mode of origin.

38. It has been already stated that the filaments which I believe to constitute the "white substance of nervous fibre," are often seen to be, not longitudinal, but curiously interlaced (fig. 102 γ), as though each filament ran in a spiral direction. The appearance has been very much like what would be produced by an elongation of the spirals in fig. 60 (compare this with fig. 102 γ), supposing many spirals to be present instead of two. Now fig. 60, though ideal, represents, apparently, no more than an advanced state of the object fig. 22. In fig. 22 the spirals α and β *run in opposite directions*; and were β to have attained the size of α, we should have fig. 60, with a central row of nuclei for the production of other spirals, which spirals would make the resemblance to fig. 102. γ still more complete†.

39. The frequent interlacing (fig. 102 γ), and apparently spiral direction, of the filaments in nerves, now referred to, seems the more deserving of attention, from my having found spirally directed filaments so very general in the retina, brain, and spinal chord (figs. 17 to 22, 72, 77, 80 to 82, 85, 99). Farther, I have noticed spirally directed filaments, on being broken, to recoil (figs. 80, 81). Such a change in the "white substance," taking place within a tube, might produce varicosities; and those minute isolated masses, hitherto called granular, by which it has been usual to distinguish nerve.

40. In the course of my investigations, I met with a curious object in the lachrymal gland, more resembling a nerve than any other structure, the appearance of which

† As already mentioned, there were spirals between α and β in fig. 22; which I have not introduced. Their presence gives an additional resemblance to fig. 102 γ. From the above remarks, it appears that a state like that in fig. 60 may be produced in two ways. See par. 27.

I am acquainted with. This body, sketched in fig. 118, was composed of flat filaments (β, γ), and had a loop-like termination, to the very extremity of which,—that is, into the loop itself,—the filaments in question were continued, and which indeed they formed. Nothing was seen in this object besides filaments, longitudinal and spiral, for no membranous covering could be discerned. A remarkable crossing of the filaments of opposite sides (α), was noticed between the trunk of this object and its loop.

Facts observed in the Formation and Structure of Muscle.

41. In May 1840, I offered to the Society some remarks on the origin of muscle†, in which it was mentioned that I was then unable to state the mode of formation of the fibrillæ within the cylinder. Subsequent observations, to be presently detailed, seem to throw some light upon that subject. In the mean time, however, a memoir by W. Bowman has been read, "On the Minute Structure and Movements of Voluntary Muscle‡." This circumstance would have inclined me not to return to the subject, but for its essential connection with researches previously begun by myself; namely, those "on the Corpuscles of the Blood:" and in recording the results, I perceive with regret that in the main points they are at variance with the observations of the author just mentioned.

42. The arrangement of cells into a necklace-like object, has been referred to in a former page (par. 20): and though I have delineated cells in this state in two previous memoirs§, they are sketched in outline in the present paper, fig. 28; which represents cells derived from blood-corpuscles of the Frog. These corpuscles or cells were filled with discs (fig. 29), arisen out of the nuclei of the cells. On the disappearance of the *septa* between the cells, there is formed a tube. In early stages, this tube becomes broken, by manipulation, into fragments (fig. 30); which fragments represent, apparently, an altered state of the original cells. Within the tube there arise other tubes (see the columns in fig. 30), having their origin in the discs with which the original cells were filled. These inner or second tubes (figs. 32, 33) are met with in after stages, no longer breaking transversely into fragments, but easily separating in a longitudinal direction. Within these second tubes are nuclei (figs. 42 to 44 α), which divide, subdivide (fig. 42)‖, and give origin to discs. The discs fill the tube, arranging themselves with curious regularity (fig. 44 β), and in a manner similar to that represented by me in the Philosophical Transactions for 1841¶, as the state of blood-red discs in tubes at the edge of the crystalline lens. These discs appear to undergo changes like those passed through by their progenitors, the corpuscles of the

† In my first paper on the Corpuscles of the Blood, *l. c.*, p. 605.

‡ Philosophical Transactions, 1840, p. 457.

§ Philosophical Transactions, 1840, Plate XXX. figs. 14—17; 1841, Plate XXIII. figs. 135, 136.

‖ We thus find the same process in operation here, which I formerly described as taking place in the so-called "primary" cell,—namely, division of the nucleus.

¶ Plate. XXIV. figs. 145—148.

blood: they become rings (fig. 48 α); the rings pass into coils; and the coils unite, thus forming spirals (γ). The adjacent spirals interlace, from the peculiar arrangement, in relation to one another, of the rows of rings (par. 23). In the space circumscribed by the windings of these interlaced spirals, smaller spirals have their origin; these in turn give origin to others; and so on. An example of this, in a later stage, is afforded by fig. 58. Here, α represents the outer or larger spirals; and β the situation of the inner or smaller ones. The outer spirals gradually disappear, *by entering into the formation of the common investing membrane* discovered by SCHWANN, and in its formed state well described by BOWMAN, who proposes to denominate it the "sarcolemma†." This may perhaps explain the mode of origin of the darker of the longitudinal striæ, three of which are represented in fig. 63 (β, β, β): these being apparently the situations of membranous partitions or *septa* (par. 53), passing into the interior of the fasciculus from the common investing membrane.

43. The process just mentioned, of smaller spirals arising in the space circumscribed by the larger ones, with the gradual disappearance of the latter, seems to be continued in later stages‡. The number of the spirals becomes continually greater, and their size more and more minute (figs. 95, 58, 65), until they reach the number and minuteness represented in figs. 96, 63: and they attain even a smaller size.

44. The outer spirals being formed of the outer or ring-like portions of the discs (fig. 48 α), the inner spirals appear to have their origin in the inner part, or nucleus of these discs: and when the inner spirals in their turn enlarge, and new ones form in their interior, the origin of the new spirals, also, seems to take place in the line of continually renovated nuclei; and so on.

45. Fig. 63. presents a state of the muscle-fasciculus, in which it contains what is denominated the "fibril," of a very minute, though not the minutest size. This "fibril" is no other than a state of the object which I have called a flat filament: and which, as we have seen, is a compound structure. The figure (fig. 55) and description (par. 14) by which I have endeavoured to explain the structure of the filament, are especially applicable to the muscular "fibril." This "fibril" I find to be, not round and beaded, as it has been supposed, but a flat and grooved filament, consisting of two spiral threads, running in opposite directions, and interlacing at a certain point (α fig. 55) in every wind. A transverse section of this filament, as before mentioned, is rudely represented by the figure 8§.

† SCHWANN is the discoverer of this membrane; but we are indebted to BOWMAN for the only complete description hitherto given of it in a formed state. Its mode of origin however, out of spirals, is for the first time described in the present memoir.

‡ In young fasciculi I have noticed a transverse space to extend far into the interior; which is not the case in those more advanced, the cause being the disappearance of the outer and larger spirals, and the continual formation of inner and smaller ones.

§ I have often seen a filament ("fibril") becoming a *fasciculus* (par. 44). See figs. 56, 57, 84, 64 γ. Enlarged filaments are well seen in the heart of the Turtle.

46. This flat filament is so situated in the fasciculus of voluntary muscle, as to present its edge to the observer (fig. 62); the curves of only one of its two spirals being seen. After removal, also, from the fasciculus, the filament very frequently lies, more or less, upon its edge. It seems to have been the appearance presented by the edge of this filament—that is to say, by the curves of a spiral thread,—that suggested to SCHWANN the idea of longitudinal bead-like enlargements of the fibril, as producing striæ in the fasciculus of voluntary muscle.

47. In my opinion, the dark *longitudinal* striæ are spaces (probably occupied by a lubricating fluid) between the edges of flat filaments, each filament being composed of two spiral threads: and the dark *transverse* striæ, rows of spaces between the curves of these spiral threads. If the *dark* longitudinal striæ are spaces between the edges of flat filaments, it follows that the *light* longitudinal striæ are the edges themselves of these filaments. And if the *dark* transverse striæ are rows of spaces between the curves of spiral threads, the *light* transverse striæ are of course the visible portions themselves of these spiral threads.

48. I repeat, that the longitudinal filament in the fasciculus of muscle, appears to be composed of two spiral threads, only one of which is seen, from the edge of the filament being directed towards the observer. This filament, or its edge, seems to correspond to the *primitive marked thread* of FONTANA; to the *primitive fibre* of VALENTIN, and SCHWANN; to the *marked filament* of SKEY; to the *elementary fibre* of MANDL; to the *beaded fibril* of SCHWANN, MÜLLER, LAUTH, and BOWMAN; and to the *granular fibre* of GERBER.

49. In the Philosophical Transactions for 1840 (p. 605), I suggested that, were the nucleus of the blood-corpuscle the seat of changes such as I had witnessed and described in other cells, the nucleus might produce the muscular fibril. The foregoing observations show that the conjecture then offered has been realized: but, I must add, in a most unexpected manner.

50. The chief physiological inferences deducible from a spiral form of the finest threads of muscle, will I think be obvious. At all events, it would be premature for me to introduce remarks on this subject at any length, before my researches are confirmed by those of other observers. Yet there are two or three conclusions that seem called for, in connection with the foregoing facts.

51. Every one knows that in proportion as a spiral is shortened, the spaces between the curves of the spiral are made smaller, and the diameter of the spiral expands: while, in proportion as the spiral is lengthened, as by removing further asunder its two ends, the spaces between the curves of the spiral are made greater, and the diameter of the spiral is diminished. This may serve to illustrate what takes place in a muscle; which is no other than a vast bundle of spirals: showing that the muscle in contraction should be short and thick; while upon the other hand, in relaxation it should be long and thin (compare α and β in fig. 66).

52. A flattening of "segments" or "particles" in the contraction of muscle†, therefore, seems not to be required: and indeed I have in no instance met with segments or particles, which could undergo this change in form. But fig. 66. affords proof that the change contended for really takes place; this figure exhibiting the appearance of two parts of the same fasciculus, that were actually seen; the one, α, being in a contracted, and the other, β, in a relaxed state: and the difference between these two conditions, was seen to result from a difference in the direction of the spirals. At one part, α, the fasciculus being shortened, the spaces (striæ) between the curves of the spirals were made smaller, and the fasciculus was thick. At the part β, the fasciculus being lengthened, the spaces (striæ) between the curves of the spirals were made greater, and the fasciculus was thin.

53. The edges of the flat filaments ("fibrillæ") in voluntary muscle being directed towards the observer, the flat surfaces of these filaments are in contact with one another (except where *septa* intervene, par. 42). And those parts of the spirals of two filaments, so in contact, fit together with the most perfect exactness and regularity, appearing to overlap one another, as viewed *in situ*. The adjacent parts of spirals thus glide harmoniously into a change of place. It will be seen that the view of a recent author, in regard to "segments," was of this kind; but then he found it needful to suppose adhesion of the segments in some way to one another‡. And he appears to have figured as bead-like segments§, what I consider the overlapping parts of spiral threads.

53½. Many of the drawings that accompany the memoir (figs. 58, 59, 65, 93—95) show that there are states of voluntary muscle, in which the longitudinal filaments ("fibrillæ") take no part in producing the transverse striæ; these striæ being caused by the windings of spirals, within which very minute bundles of longitudinal filaments are contained and have their origin. The spirals are interlaced (fig. 64 α, β, γ). When mature, they are flat and grooved filaments, having the compound structure above described. With the shortening of the longitudinal filaments ("fibrillæ") in muscular contraction, the surrounding spirals—and of course the striæ—become elongated and narrow: while in relaxation, these changes are reversed. The "convoluted filaments" regarded by GERBER as "enigmatical‖," were evidently no other than distorted spirals¶.

54. The spiral form of the ultimate threads of muscle, above described, will I think elucidate several facts already known, but as it appears to me, not satisfactorily explained. Thus, for instance, combined as I find these spiral threads of muscle, and situated one within the other, there cannot well be much difference in their lengths, when the fasciculus is broken off. Hence in part, probably, it is that the fasciculus

† BOWMAN, *l. c.*, pp. 493, 494. ‡ Ibid. *l. c.*, p. 470. § *L. c.*, fig. 10 *b*, *c*, fig. 11.

‖ "Elements of the General and Minute Anatomy of Man and the Mammalia." Fig. 83. Explanation of the Plates, p. 35.

¶ This paragraph was communicated to the Society as a Postscript, Jan. 11, 1842.

usually breaks off short. The membranous partitions or *septa*, above described (par. 42), no doubt contribute to prevent a difference in length. Besides which, fig. 123. shows that there are states in which the flat filaments ("fibrillæ") are shared by more than one surrounding spiral. See the additional observations, par. 119. I would also suggest that the spiral form of the ultimate threads of muscle, shows why it is that, before being broken off, the fasciculus sometimes becomes tapered to a point. An instance of this kind is to be seen in fig. 67, representing two portions of the same fasciculus. In α, the direction of the curves of the spirals is comparatively transverse; and this part of the fasciculus is thick: in β, the direction of the curves becomes more and more oblique, until the fasciculus, rendered in the same proportion thin, terminates at last in a point. A very distensible membrane invests the fasciculus to the extremity; being one of the means by which its spiral contents are held together, during this violent elongation.

55. In a former paper†, I stated that membranes appeared to arise from the coalescence of discs. Fully confirming this observation, I have now to add, that, in some instances at least, the discs first form flat filaments, such as those above described; which filaments become interlaced with other filaments, divide, subdivide, and coalesce to form the membranes. The cellular tissue entering into the formation of the sheath of the spinal chord, we saw to become interlaced for this purpose‡: and in an earlier series of investigations, I found the incipient chorion to present an appearance somewhat the same§. The present memoir contains examples of membrane being formed out of interlacing filaments. Muscle presents an instance of membrane, that of the fasciculus, forming by the interlacement of mere spiral *threads*, many of which are too minute to admit of their structure being investigated. But the larger of these threads present a compound structure (figs. 125, 68), which admits of being traced into the objects I have termed flat filaments: and minuteness is no hindrance to the smallest undergoing a like change. The origin of this membrane out of spirals, may assist to account for its remarkable distensibility, elasticity, and toughness, pointed out by Bowman. This author indeed remarks, concerning it, that though from its minuteness and transparency, "it is difficult to form any decided opinion as to its structure *** it would seem not improbably to consist of a very close and intricate interweaving of threads far too minute for separate recognition." But he adds, that "the matter is very doubtful‖."

56. In the mammiferous ovum, we saw the first cells succeeding the germinal vesicle to be few and large; and that there occurred a doubling of their number with every diminution in their size¶. The same process, essentially, we have since found

† Philosophical Transactions, 1841, pp. 209, 230, 243.
‡ Ibid., 1841, Plate XXII. fig. 116.
§ Ibid., 1840, Plate XXVIII. fig. 252.
‖ *L. c.*, p. 478.
¶ Philosophical Transactions, 1840, p. 539.

to be in operation in the blood-corpuscle at certain periods†, and in tables of the epithelium‡. To meet with a re-appearance of anything like this process, however, in spiral fibres, I was not prepared. Yet here also, something of the kind is actually seen. For, as above described, within the space circumscribed by the windings of a larger spiral, there arise smaller ones, which are sometimes two in number. There is, besides, another way in which the process just referred to re-appears. A spiral, originally single, gives origin to others in the interior of its *substance* (fig. 71), and thus, by division and subdivision, gradually acquires considerable breadth (fig. 69), or there may be thus formed several separated spirals (figs. 73, 113 α α).

57. It will be seen, from the account above given of the formation of the muscular fasciculus, that the young fasciculi have the largest and fewest spirals. In the very young Tadpole, I found a great many fasciculi of this kind: while in the older Tadpole, such fasciculi were less numerous. The fasciculi here presented, generally, an increased number of spirals, with a diminution in their size.

58. I cannot doubt that the larger spirals perform contraction, as well as the smaller. It is probable that the difference between the contractile force of muscles in childhood and in adult age, is connected with the above-mentioned difference in the number of the spirals. Nor is this supposition inconsistent with the fact, that muscle by constant exercise increases in its bulk.

59. My observations on the form of the ultimate threads in voluntary muscle, first made on the larva of a Batrachian Reptile, have been confirmed by an examination of this structure in each class of vertebrated animals, including the scaled Amphibia, and Cartilaginous as well as Osseous Fishes. Such of the Invertebrata, also, as happened to be easily obtainable, were examined, and afforded ample confirmation of those observations. They included animals in the *Crustacea* (Crab), *Mollusca* (Limpet, Clam, Cockle, Mussel, Garden Snail, Periwinkle, Whelk), *Annelida* (Earthworm), and *Insecta* (a kind of Caterpillar).

Facts observed in the Formation and Structure of the Crystalline Lens.

60. In the Philosophical Transactions for 1841 §, I delineated cells, first arranged, like the beads of a necklace, in a line; and then, by the disappearance of the intervening *septa*, forming a tube, the foundation of the fibres of the Crystalline Lens ‖.

61. I have now to state, that within this tube there are formed, in the first place discs (fig. 129), and then filaments (fig. 130 α), having precisely the same structure as the filaments of other parts. Nowhere have I obtained more satisfactory evidence, than in the lens, that these filaments are composed of two spiral threads (fig. 131 β, γ), and that the spirals give origin within their winds to other filaments.

62. The toothed fibre discovered by Sir David Brewster in the lens ¶, is formed

† Philosophical Transactions, 1841, p. 204.

‡ Ibid., 1841, pp. 223, 224.

§ Plate XXV. figs. 157, 158.

‖ I find that this observation was previously made by Valentin. See Wagner's Physiologie: erste Abtheilung, p. 138.

¶ Philosophical Transactions, 1833.

out of an enlarged filament; the projecting portions of the spiral threads in the filament, that is, the apparent segments, becoming the teeth of that fibre. And here it is important to refer to a remark made in a former page (par. 16), that the filament has a tendency to become membranous at the surface, and that it contains within itself the elements of other filaments: both of which qualities may be recognized, as the filament is passing into the toothed fibre.

63. From my observations on vegetable structure, to be presently referred to (par. 68), I venture to anticipate that the toothed fibre noticed by SCHWANN in the epidermis of a Grass, and considered by him as corresponding to that of BREWSTER in the lens, will be found to have the same mode of origin.

Facts observed in the Structure of Blood-vessels, Mould, Woody Fibre, Hair, Feathers, &c.

64. In examining the coats of a large blood-vessel, I had noticed the filaments of one stratum to cross those of another stratum at right angles. But what was my surprise, when subsequently directing my attention to the structure of the arachnoid, at the remarkable display of filaments in the vessels of the pia mater (fig. 16.)! There are few parts in which the flat and compound filaments ("fibres"), so constantly mentioned in this memoir, are more easily or more distinctly seen, than here. The coats of such of these vessels as are empty, or nearly so, present an inner stratum of filaments having a longitudinal direction, and an outer filament spirally crossing these. In the coats of such of these vessels as are full, the outer or spirally directed filament is wanting. Vessels with the same structure are met with, having many times the diameter of the largest of those in fig. 16.

65. I saw in the olfactory nerve, blood-vessels having two sets of filaments such as those now described, as existing in the pia mater; and their diameter so small, as to admit the blood-corpuscles in only a single row. It is deserving of remark, that the corpuscles observed in this row, presented indications of division into corpuscles of minuter size.

66. We thus find blood-vessels, the walls of which consist of filaments, having the same structure as those filaments which the blood-corpuscle forms. In connection with the spiral direction of the outer filament in these vessels (fig. 16 β), as well indeed as with many facts recorded in this memoir, I refer to the *rouleaux* in which the blood-corpuscles are seen in the microscope to arrange themselves, as probably indicating a tendency to produce spiral filaments. To form *rouleaux*, corpuscle joins itself to corpuscle, that is to say, ring to ring, and rings, as we have seen (par. 34), pass into coils. The union of such coils, end to end, would form a spiral. But the formation, by the blood-corpuscles, of these *rouleaux*, is no less interesting in connection with facts recorded in a former memoir; namely, that structures, including blood-vessels, may be seen to have their origin in rows of cells derived from corpuscles of the blood.

67. I have noticed very curious resemblances in mould, arising from the decay of

organic matter, to early stages in the formation of the most elaborate animal tissues, more particularly nerve and muscle. Of such mould, figs. 25, 26, 34, 78, 97, and 104 may serve as examples. They present, it will be seen, mould from a ripe berry, and from decomposing animal substances, including cheese. Some of these figures (figs. 25, 26 $\beta\,\beta$) represent cells, which have applied themselves to one another, and elongated; in one (fig. 26 γ), discs have arranged themselves in rows; in another (fig. 25), interlacing spirals have formed (out of discs); in a third (fig. 26 δ, ε), there are seen rings; in a fourth (fig. 26 ζ), spiral filaments have been produced, and become elongated; and in a fifth (fig. 78), a bundle of longitudinal filaments is surrounded by one having a spiral form. The plates present very similar appearances, observed in the most important structures of the animal economy.

68. Flax has afforded most satisfactory evidence of identity, not only in structure, but in the mode of reproduction, between animal and vegetable "fibre." We here find the same division of filaments into minuter filaments, and these again into filaments still more minute: as in fig. 76 α, β, γ, δ—states which were noticed in the same fasciculus of flax. There is also seen the same coalescence of some spirals, to form an investing membrane (figs. 109, 110) as is observable in muscle, while others retain the spiral form, and undergo the same division (fig. 113 α) and subdivision ($\alpha\,\alpha$). In flax, filaments are frequently met with running in opposite directions around the fasciculus, and forming knots (fig. 101). Some of the flax-fasciculi afford evidence of a continued origin of new spirals in the same centre, after a considerable size has been attained (figs. 109, 110); these spirals being curiously interlaced.—See the description of figs. 109, 110. Very similar appearances, we have seen in nerve (par. 28). All the filaments in flax now mentioned consist of spirals, connected in the manner above described (par. 14), as their mode of combination in animal tissues.

69. The difference in the degree of developement exhibited by a flax-fasciculus in different parts, is sometimes very great. Thus the three conditions α, β, γ, represented in fig. 75, were noticed in the same fasciculus of flax.

70. In cotton, I found appearances of the same kind as those observed in flax†.

71. Hair (fig. 139) presents the same kind of longitudinal filaments, as well as spiral filaments; some of the latter appearing to be curiously interlaced, and others coalescing to enter into the formation of the investing membrane. Besides the hair, of which a sketch is given in the figure, I have examined that of the Bat, Mouse, Mole, Rabbit, Sheep, Hog, Horse, Polar Bear, and Elephant, as well as the hair of Man; finding in all instances the filaments in question.

† It is a little singular, that the flax above mentioned had been spun and woven into the linen cloth used for drying the strip of glass on which the objects lay when examined; portions of these flax-fasciculi detached from the cloth remaining adherent to the glass. I found compound filaments, such as those above described, even in paper, and in dry cork; in Leghorn grass, taken from a hat; in the cedar-wood of a pencil; and in hemp that had been twisted into twine.

72. Certain hairs of plants have presented these filaments with great distinctness. Such has been the case also with the pappus of the *Compositæ* (fig. 126). I have examined the pappus in the Sow Thistle, Common Groundsel, and the Dandelion. In the stinging hair of the Common Nettle (fig. 128), the filament is arranged in a manner connected probably with the properties of this hair: the filament, formed, as in other cases, of two spiral threads, being itself coiled spirally upon the inner surface of each hair.

73. I have rarely seen the filaments in question more distinctly than in feathers from the chick *in ovo*, incubated fifteen days. The quill extremity exhibited them of larger size than the shaft.

74. I recognize spiral threads in the feather-like objects from the wing of the Gnat and Butterfly (fig. 141). In the latter they give rise to both longitudinal and transverse striæ. They are largest at the middle part, near the quill: but it requires close attention, and a very good light, to discern them at all in these objects, so minute is their size, and so closely are they packed together.

75. As already stated (par. 16), many are the instances in which the microscope fails to detect more than a grooved filament; the originally crenate edge presenting an unbroken line. Such is often the case in the Spider's web. Yet here also, filaments composed in the above way, are to be discerned (figs. 142, 143). Tension renders the filaments of this web less distinct; or rather, relaxation makes them more so. Sometimes they are single (fig. 143); sometimes two, three, or a larger number (fig. 142), are combined. Knots are sometimes met with, as though a broken filament had undergone repair.

76. I wound on a strip of glass the cord which a spider was giving off as it descended, for the purpose of making its escape; and found this cord to consist of a single grooved filament, in which a crenate edge was no longer to be seen. It has been already stated, that in one kind of cartilage, I found the nucleus of the cell to present the same appearance as a ball of twine. No doubt it is by a provision somewhat similar, that the Spider is prepared for an emergency such as that now mentioned: and indeed for the formation of its web. This seems much more probable than that the filaments are manufactured at the time when used.

77. When we see a corpuscle enlarging and becoming filled, in one instance with epithelium-cylinders†; in another with objects having the appearance of fat-globules‡; in a third with rudimental ova§; in a fourth with the materials for bundles of spermatozoa‖; in a fifth with columns of discs for the formation of nervous substance¶; in a sixth with like columns for the origin of muscle (figs. 28, 30); and in a seventh with similar columns for forming the mould of cheese (fig. 26 *γ*),

† Philosophical Transactions, 1841, Pl. XXI. fig. 94.
‡ Ibid. Pl. XXI. fig. 103.
§ Ibid. Pl. XXV. fig. 164.
‖ Ibid. Pl. XXV. figs. 160 to 162.
¶ Ibid. Pl. XXIII. fig. 125.

we cannot but be struck with the great uniformity in type in the earliest stages of formation, however widely different the structures ultimately formed.

78. On a late occasion†, I showed the foundation of the new being, in what are called the highest animals, to have the same structure as that of the simplest plant. We now find this uniformity in type to be recognizable at later periods. For, not only does every tissue seem to arise out of discs having all the same appearance, but the primary arrangement and early metamorphoses of these discs seem to be the same. We recognize the same combination of spiral threads in the mould of cheese, as in the brain of Man. How wonderful the fact, that out of materials so similar, structures should be formed endowed with properties so different!

79. I have had an opportunity of examining the spermatozoon from the epididymis of a person who died suddenly‡. The large extremity appears to me to be a disc, the pellucid depression in which, corresponding apparently to the "sugient orifice" of some authors, is probably analogous to the source of new substance in other discs. Each of the two sides of the peripheral portion of the disc is extended into a thread: these two threads forming, by being twisted, the part usually designated as the tail; an appendage the office of which appears to be to "scull" along to its destination the essential part or disc, and *more particularly its pellucid centre*. The formation of the "tail," as now described, out of two twisted threads, seems to explain the observation of R. Wagner, who, in rare instances, met with the caudal part double (as I suppose, untwisted) at the end. The *caudal* portion of the spermatozoon in the Rabbit presented a similar structure.

On the Structure and Mode of Increase of the Vegetable Spiral.—On the Reticulated Duct, Annular Duct, and Dotted Duct of Plants.

80. Having added to spirals from the leaf-stalk of the strawberry, a spiritous solution of corrosive sublimate (par. 7), I soon discerned in their substance something like a compound structure. In about half an hour, the interior of these spirals presented the appearance at α in fig. 71: that is to say, they were seen to contain two filaments, such as those above described. I therefore consider these spirals to be reproduced in the same manner as those of muscle (figs. 68 to 70 and 73) and of flax (fig. 113 α, α α), which I find to become double and quadruple by self-division.

81. It may be added, that, were the division of the spiral, or at least the separation, to be complete in some parts and not in others, the appearance would resemble that of what is called the "reticulated duct." And the tendency (as it is supposed) of vegetable "fibre" to anastomosis, might be thus explained.

82. Rings have been mentioned (par. 34), as observed in animal structure; which rings divide, and pass into coils. Coils are met with (fig. 22 β) that are equidistant,

† Philosophical Transactions, 1839, p. 372.

‡ For which I am indebted to the kindness of my friend Robert H. Cooke of Stoke Newington.

and in a line. It appears to be by the union of the adjacent extremities of coils, that there is produced the spiral (see the same figure). Corresponding rings and coils in plants, I have not seen nor sought for: but, with so perfect an analogy before me as that above described, I do not find it easy to believe that they can be deficient there. Now were such rings not to form coils, nor even to divide, but simply to enlarge, a line of them, equidistant within a tube, would have very much the same appearance as the "annular duct" of plants.

83. If the appearances delineated in figs. 87, 88, 89, 90, as noticed in the roots of a plant, be compared with those in fig. 25, from mould; in fig. 91, from the cornea of the eye; and in fig. 131, from the crystalline lens; as well as with figures of voluntary muscle in the lower line Plate VIII., and in other Plates, I think it will not be easy to refrain from believing the appearances in all to be produced by the same kind of structure. This structure, in such of the figures now mentioned as were previously referred to, we have seen to possess a spiral form. As already stated with reference to muscle (par. 42), spiral is formed within spiral; and the outer spirals more or less completely coalesce to form a membrane. The vegetable figure, fig. 90, seems to represent an advanced state of such as that in fig. 87. In both, as well as in fig. 88, spirals were observed within a tube. These spirals appeared to interlace with one another; and, by their close contact (fig. 90), to produce the appearance of transverse and elliptical "pores" or "dots." The apparent "dots" or "pores" I believe were no other than spaces between the winds of spirals, contained within a tube. Now spirals *interlacing* in the above way (figs. 87, 88, 90) must, by a longitudinal succession of their winds, produce *septa* (fig. 90 α) in the containing tube. I cannot help believing that these observations will assist to solve the still undecided question, as to the structure of the "dotted duct." In short, I find it difficult to refer the appearance of the "dotted duct" to any cause but that above described, as producing the striæ in voluntary muscle (par. 53½).

84. The filaments in plants have often appeared to me to be so placed, that, by alternate contraction and relaxation, they might influence the contents of cells. And surely the structure of these filaments is sufficient to induce the belief, that they perform an important office in the circulation, including the elevation of the sap. An office of this kind may perhaps belong to spirals in the roots, and elsewhere, such as those in figs. 87 to 90; exhibiting, as some of these do, almost transverse striæ, like those of voluntary muscle in animals.

85. A structure presenting the same appearance as that of the essential part of muscle, being found to pervade, it may be said, all other tissues, it is evident that this structure alone does not account for the contractile property of muscle. To what then is the contractile property of muscle owing? This inquiry my observations do not enable me to answer. It is the duty of an investigator to record the facts he

meets with; difficult as they may be to account for, or even paradoxical as at times they may appear.

86. It seems probable, however, that to the *spiral* structure of the filament ("fibre"), we may attribute the elastic and resilient qualities of certain parts; such as elastic tissue, and cellular tissue, as existing in and under the cutis, and in the parenchyma of the lungs; the latter being intimately connected with the question, whether the lungs are resilient in expiration.

87. Other parts in which the filament is found, as for instance some portions of the cutis, are capable of becoming *constricted*. The existence of filaments may be connected with that constriction.

88. There is, however, one structure in which I have met with the filaments in question, that possesses neither elasticity nor resiliency, nor the property of undergoing either contraction or constriction,—bone. This objection I have not the means of answering: but may be permitted to remark, that although its original developement (the formation of its cartilaginous state) is after the same type, its completion, for a special purpose, is effected by the addition of bone earth.

Analogy between the Tissues of Animals and Plants, after (as well as before) their Formation is complete.

89. The remarkable uniformity in structure between the elements of animal and vegetable tissues, pointed out by SCHWANN, I showed in the Philosophical Transactions for 1840, to begin with the first foundation of the new being. It will now be seen, I think, from the foregoing observations, that a degree of this analogy between animals and plants exists, not merely in the elements of their tissues, but after the formation of the tissues is complete.

90. That the nucleus of the vegetable cell, instead of being "absorbed as useless," after the formation of the cell-membrane, performs a part not less important than that which I have described as appertaining to it in animals, there can be no kind of doubt. I happen to have incidentally met with the germinal granules of the mushroom (fig. 27), and of the mould of cheese (fig. 26); and have figured them, as presenting evidence of this kind. Too much importance, it appears to me, has been attached, of late, to the *membrane* of the cell; while the source of the contents of the cell, and apparently of all "secondary deposits," that is, the *nucleus*, has been overlooked.

91. It is stated by VALENTIN that in plants, all "secondary deposits" take place in spiral lines. I have already remarked, that in animals, spirals have heretofore appeared almost wanting. Should the facts recorded in this memoir, however, be established by the researches of other investigators, the question in future may perhaps be, where is the "secondary deposit" in animal structure, which is *not* connected with the spiral form? But more than this: the spiral in animals, as we have seen, is in strictness not a "secondary" formation; it is the most *primary* of all. And the question now, is whether it is not precisely so in plants.

Additional Observations.

Received April 27,—Read May 5, 1842.

92. I have the satisfaction of stating that since the foregoing memoir was presented to the Society, many gentlemen have afforded me the opportunity of demonstrating to them, either with my own microscope, or with instruments made by POWELL, Ross, or SMITH, the leading facts recorded in it. To one of them (the son of an eminent physiologist, Dr. BOSTOCK) I am indebted for sketches of some of the appearances he saw. Two of these (figs. 145, 146) represent the filament within blood-discs: another (fig. 144) shows a similar filament constituting the muscular fibril. At α, this filament is on its edge: at β, it presents its flat surface. What gives peculiar value to these sketches, is that they were made by one who then for the first time saw the objects in question.

Facts observed in the Coagulation of the Blood.

93. In the examination of coagulating blood, discs are seen having two very different appearances: the one kind comparatively pale, the other very red. It is the latter discs in which a filament is to be found, and which enter into the formation of the clot: the former being merely entangled in it, or remaining in the serum. Observers having directed their attention almost exclusively to the undeveloped discs so remaining in the serum, it is not surprising that they did not discern the filament in question: or that they supposed the blood-discs to be of subordinate importance, and to have no concern in the evolution of the fibrin.

94. In order to see distinctly the filament within blood-discs, some chemical reagent should be added, that will remove a portion of the red colouring matter, without dissolving the filament itself. I have employed for this purpose either the substance before mentioned (corrosive sublimate par. 7), or chromic acid†, or nitrate of silver‡,—and chiefly the last.

95. An objection has been taken to the employment of chemical reagents. It may be replied (as suggested by my brother JOHN T. BARRY),—if the point to be proved by the use of chemical reagents had been, that there exists *no visible structure*, then the use of those reagents would have been objectionable, because of their known destructive tendency in a concentrated state. As, however, the point to be proved is, that *a peculiar structure does exist*, it is not too much to assume, that the appearance of a structure so remarkable could not possibly be produced by the chemical action of one of those reagents, the mercurial compound for instance, when it is also

† Sp. gr. about 1·040.

‡ A solution consisting of 1 part nitrate silver in 120 water.

shown that the same structure is rendered visible by other reagents; such as the compounds of silver, and of chrome. It is singular that the objection to the use of chemical reagents should have been mooted by parties in the habit of employing maceration, a process of course highly destructive when prolonged for many days.

96. But the filament may be discerned without any addition whatever, if the coagulation has begun, provided its appearance has become familiar to the eye. In the blood of the Newt when so viewed (i. e. without any addition) the discs containing filaments often resemble flask-like vesicles (fig. 149). The membrane of most of the little flasks exhibits folds or creases (β), converging towards the extremity of the neck. If this extremity is very carefully examined, it is often found that there is a small body protruding (γ): this is no other than the extremity of the filament in question. It is now sometimes possible to discern that the folds just mentioned, mark the situation of the filament within the flask (δ). Occasionally a portion of the filament protrudes, sufficient to admit of its remarkable structure (par. 6) being seen. Sometimes the neck of the flask is bent (β); so that, with the filament, there is produced the appearance of a comma. Still, as before said, for a complete examination of coagulating blood, it is advisable to remove a portion of the red colouring matter by some chemical reagent†.

97. There is considerable variety in the appearance of the red portion of the clot. In that of various Mammals, I have seen the following objects: namely, 1. parent cells‡ (fig. 148 α) filled with young corpuscles, resembling Ammonites; 2. groups of young corpuscles (β), each of which was unwinding into a filament, and comparable to a Turrilite in form; 3. similar objects of larger size (γ), also in groups, as if discharged from parent cells; 4. spiral *fasciculi* of filaments (δ), such as would be produced by the continued elongation and self-division which is represented as incipient in the corpuscles at γ. In other instances, the fasciculus of filaments has seemed to arise directly out of a parent cell; by the simultaneous metamorphosis, into filaments, of all the contained blood-discs.

98. The undulations to be observed in the filaments of "cellular" tissue, seem re-

† When first endeavouring to find the filament in question, the observer should use the clot in blood of the Frog or Newt, three or four hours drawn. Having placed upon a strip of glass a drop of the solution of nitrate of silver, introduce into it a portion of this clot; and with needles break the same into very minute parts; cover these with a piece of thinner glass; press the two glasses firmly together; and view with a power of 400 or 500 diameters. To find the little flasks above described, proceed in the same manner, and use the same clot, but without adding any chemical reagent. Blood (of one of the same animals) should then be examined, first with, and then without chemical reagents, just before its coagulation: and subsequently at various periods during the formation of the clot. I generally employ the Newt (*Lissotriton punctatus* of Bell): and obtain the blood by touching a strip of glass with the part from which the head has been removed; immediately adding a drop of the solution of nitrate of silver, and then a piece of thinner glass. This is done at the end of half a minute, and repeated in one minute, &c. for two or three minutes. The first perceptible changes in coagulation may be thus observed.

‡ These parent cells, usually elliptical, measured in length from $\frac{1}{600}'''$ to $\frac{1}{50}'''$ (Paris line), and were met with even of a larger size. Their colour blood-red.

ferable to a spiral mode of origin, similar to that producing the fasciculus of filaments in the clot fig. 148 δ. And the formation of spirals out of discs in the clot of blood resembles in a striking manner that described in the foregoing memoir, as witnessed in the formation of certain tissues: for instance, nerve and muscle. I have just mentioned the reproduction of filaments by self-division (fig. 148 γ, δ) as noticed in the clot: a process obviously the same as that described in the memoir as observed in the tissues. But the analogy does not end here. In a former communication† I figured blood-corpuscles (cells) from which the contents, except the nucleus, had been removed by acetic acid. If those figures be referred to, it will be found that the nucleus so remaining is in many instances *double*. An examination of coagulating blood enables me now to offer some explanation of this curious fact.

99. In fig. 150 is sketched a blood-corpuscle (cell) presenting a coiled filament, α. This coil having arisen out of the nucleus of the corpuscle or cell, the residual portion of the nucleus became double by self-division: and then each half of the nucleus formed a coil, so that an outer coil contained two smaller coils (β, β), each having a pellucid centre for future change. We here again find a process in operation, bearing a striking resemblance to that producing tissues.—Compare with fig. 147.

100. Where the supply of nutriment goes on, this process of self-division, and the formation of new solid substance, are continued until an entire tissue is produced. Where that supply is soon exhausted, as in coagulating blood, the process in question is speedily at an end. But here also, as in the tissues, greater firmness is acquired as new substance forms. When the supply of nutriment is exhausted, there is no longer a renovation of the nucleus: and now there is seen a cavity (fig. 152 α). This appearance is very frequent in the advanced clot.

101. The best delineations I have met with of coagulated blood, are those by G. Gulliver‡. They are to be explained, I believe, by the facts above mentioned: as well as those given by the same observer of morbid growths§; which, like healthy tissues, have their origin in corpuscles of the blood‖.

102. In the blood-clot, corpuscles are seen of a much minuter size than those usually circulating in the animal. Such corpuscles are constantly met with in the clot of the Frog and Newt. They owe their origin to previous corpuscles; a filament is often to be seen within them; they are frequently membranous at the surface; more or less spherical in form; and generally of a deep red colour.

103. In a former paper, when describing the origin of the various structures of the body in corpuscles of the blood, I mentioned having noticed a reproduction of red

† Philosophical Transactions, 1841, Part II. p. 201. Plate XVIII.

‡ In Gerber's "Elements of the General and Minute Anatomy of Man and the Mammalia," Pl. XXVIII.

§ Ibid. Plates XXIX. XXXI.

‖ Dr. Hodgkin informs me that in some perfectly recent cancerous matter which contained particles in many respects resembling those of the blood of reptiles, he saw great numbers of them having an unequivocal tail-like process appended to them, which was evidently formed from the material surrounding the nucleus.

colouring matter also. The evolution of red colouring matter forms one of the most remarkable changes in the coagulation of the blood (par. 93).

104. The prodigious rapidity with which filaments form during the coagulation of the blood, will be obvious from the short space of time occupied by this process; of which the production of these filaments seems to constitute the leading part.

105. The "notched or granulated fibres" observed by Professor MAYER in the blood†, were possibly my flat, grooved, and compound filaments, a particular description of which has been given in the above memoir; but if so, there is this important difference between the opinion of Professor MAYER and my observations as to their mode of origin. He regards them as representing "free fibrin in the blood," and, from having seen more of them in inflammation, as perhaps the "mechanical consequence of an increased pressure of the blood, by the more rapid and forcible systole of the heart and arteries." He even thinks it possible to produce the same appearances "by drawing the plasma of the chyle into a thread." The filaments I have described are produced in neither of these ways; but, as we have seen, have their origin in corpuscles of the blood.

106. On former occasions‡, I have mentioned these corpuscles as sometimes exhibiting changes in their form. When last referring to this phenomenon, I expressed my conviction that it arose from an inherent contractile power; an idea which repeated observation has confirmed, and which has been strengthened by the very decided opinion of several gentlemen to whom I have shown the phenomenon in question. As I had noticed such an inherent contractile property in blood-corpuscles, it was very interesting to me to meet with moving filaments in some blood from the heart, that had stood for a day or two after death§. And I have since had the further satisfaction to find that the fibres just referred to as seen by Professor MAYER were observed by him in the Lamprey to present free and spontaneous motions.

107. We are indebted to W. ADDISON‖ for the discovery of an immense number of "colourless globules," sometimes observable in the clear colourless fluid at the top of coagulating blood. I have had the opportunity of examining blood presenting, in its coagulation, a top-stratum of clear, nearly colourless fluid; and what I regarded as the "globules" in question. In some blood taken in Pleuritis, I found the number of such "globules" prodigious. They obviously contained discs, the outer of which disappeared on the addition of acetic acid (of the strength of distilled vinegar): and I was not a little interested on finding the residual contents to present the same ap-

† FRORIEP's Notizen, No. 377, April 1841, p. 42.

‡ Philosophical Transactions, 1840, Part II. p. 598; 1841, Part II. p. 227.

§ The appearance of some of the blood-corpuscles when performing the movements in question, is such as to suggest the idea of a filament being contained within them.

‖ "On colourless globules in the buffy coat of the Blood," Lond. Med. Gaz., 1840, vol. xxvii.

pearances as some of those figured in one of my former communications to the Society, as resulting from the addition of this reagent to corpuscles of the blood†. It immediately became a question with me, whether some of the appearances so delineated were not those of "colourless globules;" a few of which, it is known, are seen floating along with the red discs. I therefore attentively examined blood-corpuscles in very large number, without having added any chemical reagent: and the result is, that I believe the colourless globules, floating with the red blood-discs, to be no other than these discs in an altered state‡. The colourless globules appear to represent different stages in the formation of *parent cells*, which in a former memoir I showed to have their origin in red blood-discs.

108. Acetic acid, then, produced such a change in the colourless globules at the top of the coagulating blood just mentioned, that I believe them to have been of the same kind as certain corpuscles usually floating in the blood: corpuscles paler than the rest, and termed "colourless globules."

109. Are any of the colourless globules in the top-stratum of coagulating blood concerned in producing the buffy coat? Addison believes that they "coalesce" to form it. "In a few minutes," says he, "coagulation commenced in streaks and films, all of which were evidently composed by the aggregation of the globules." The optical instrument used by Addison was merely a Coddington lens: but the employment of a compound microscope, with very high magnifying powers, has not enabled me to detect any other substance than the globules he pointed out, with the containing fluid, as giving origin to the buffy coat. The fact is, that the globules I met with were no other than *parent cells*, more or less advanced in producing young blood-discs. In the top-stratum I met with a number of these young discs, discharged from their cells, very minute and delicate, and scarcely tinged with red. When the top-stratum had coagulated, these cells were no longer found: but in their stead I saw fibres, such as those in tissues, known to have their origin in cells: not in the cell-membranes, which I find to be of very subordinate importance (par. 90), but in the discs contained within the cells. These fibres were certainly not produced by manipulation§. Among the fibres, nuclei were met with, resembling those in the tissues, which, according to my observations, are descended by fissiparous generation from the nuclei of the original cells (par. 19). In some parts these nuclei were

† Which, I should now add, were obtained by punctures of the finger. See Philosophical Transactions, 1841, Part II. Plate XVII. fig. 23.

‡ The figure just referred to, indeed, represents stages in this transition. See the description of that figure. Thus *n* had ceased to be biconcave, and become globular: but the nucleus was indistinctly seen, from the surrounding discs and *red colouring matter* having been imperfectly dissolved. Most of the objects there delineated represent *cells*, such as before the addition of acetic acid are filled with discs; only the last formed of which remain visible after the addition of the acid.

§ In a paper of later date than those above referred to, W. Addison describes the macerated clot as containing "fibres and filaments, having the toughness, cohesion, and elasticity of organized membrane." Lond. Med. Gaz., March 26, 1841, p. 14. This I fully confirm, from many observations.

less obvious: but I noticed in the same situations minute threads of a spiral form, and am inclined to think that they were the nuclei in an altered state.

110. It is gratifying to me to find in the observations of Dr. Remak† a confirmation of one previously communicated to the Royal Society by myself (and realizing an idea of Professor Owen), viz. the reproduction of the blood-corpuscles by means of parent cells‡.

111. Farther, the observations of Remak led him to believe that the blood-corpuscles of the fœtal chick of the third week are propagated by "*division*." I must here add, that division of the *nucleus* is what I have been long indicating as the mode of reproduction, not only of blood-corpuscles, but of all other cells.

112. It remains to be seen whether my further observation also, that the parent cells are altered red blood-discs, will not be confirmed.

113. According to Dr. Hannover, the pale central fibre or primitive band has no concern in producing the varicosities of nervous fibre: and from the observations of Dr. Remak, it appears that the pale sheath takes no part therein; but that it is the *opaque* sheath ("white substance") that becomes varicose§. This accords with my view (par. 39), that the varicosities result from a rupture in many parts, and a recoiling, of the remarkable filaments of which (according to my observations) the "white substance" is composed‖.

114. Since the foregoing memoir was presented to the Society, I have seen the remarkable filaments therein described (par. 6) in "false membrane," in the horny tissue of the hoof, in the chorion and amnion of one of the Mammalia, and in the chalazæ of the Bird's egg. The latter consisted entirely of them.

115. It has long appeared to me questionable, whether the generally received opinion is correct, that the chalazæ consist merely of coagulated albumen to which a spiral form has been given by revolutions of the ovum in its passage through the ovi-

† British and Foreign Medical Review, January, 1842, p. 229. From the Medicinische Zeitung, Juli 7, 1841.

‡ My paper, recording the above observation, was read January 14, 1841. See Philosophical Transactions, 1841, Part II. p. 201. figs. 39, 41 γ, 45 x, 53 β.

§ Müller's Archiv, 1841, p. 512.

‖ A friend has pointed out to me a figure by Fontana, which I am glad to have the opportunity of noticing while the paper is going through the press. It shows, I think, that this observer, sixty years since, discerned traces of the filaments of which I find the "white substance" to be composed. He describes a primitive nervous cylinder as appearing to have "ça et là sur les parois quelques fragmens de fils tortueux." (Traité sur le Vénin de la Vipère, Tab. IV. fig. 1. p. 279.)

Another friend has pointed out to me in a recent work by Valentin, that has just come into his hands (Samuel Thomas von Sömmerring, Hirn-und Nervenlehre), a passage which, so far as it goes, agrees with an observation recorded in the foregoing memoir, namely, the formation of membrane out of spiral fibres (pars. 42, 55). Valentin states that, under favourable circumstances, it is possible to discern that the delicate membrane surrounding the contents of the nerves is formed of fibres; two of which he describes as appearing to run screw-like around the tube. *L. c.*, p. 5, § 8.

duct. And the observation now recorded, that these structures consist of the remarkable filaments in question, seems sufficient of itself to warrant the belief that they have no such mode of origin.

116. I have already mentioned having seen these filaments in the shell-membrane of the Bird's egg. This membrane I believe is usually regarded as the analogue of the chorion in Mammalia. Now the chorion of the Mammal, according to my observations, has its origin in corpuscles of the blood: and it is not likely that its analogue in the Bird is produced in a different way.

117. On a former occasion†, we saw the incipient chorion, when rising from the "zona pellucida" in the mammiferous ovum, to leave a stratum of unappropriated cells behind it on the "zona," a gelatinous fluid intervening. These cells are subsequently appropriated in the thickening of the chorion. I think it possible that it may be the outer layer of the chorion just mentioned, that is represented by the shell-membrane; while the stratum of cells left for a while on the "zona" in the mammiferous ovum, finds its analogue in the chalazæ of the Bird's egg. If so, it will doubtless be found that the chalazæ also have their origin in corpuscles of the blood; which indeed their structure renders probable.

118. As already mentioned (par. 53½), many of the figures which accompany the foregoing memoir represent states of voluntary muscle, in which the longitudinal "fibrillæ" have no concern in producing the transverse striæ. In these states, the transverse striæ are caused by comparatively large interlacing spirals, which dip inwards in a manner that may be represented by making the half-bent fingers of the two hands to alternate with one another, and then viewing them on the extensor side. The longitudinal "fibrillæ" are contained within the spaces circumscribed by the interlacing spirals.

119. It is in such states of voluntary muscle, that the fasciculus "breaks off short (fig. 157)." This breaking off short is a natural consequence of the interlacing of the spirals; as may be easily shown by a wire model, representing this state of the fasciculus. The fracture of course takes the direction in which there is the least resistance. This direction is the transverse, for in any other there would be a greater number of the curves of spirals to be encountered‡. Sometimes the fasciculus, instead of being "broken off short," is merely *notched* (fig. 157). These two effects of manipulation, however, differ only in degree; the cause producing both being the same§. *This seems to be the explanation of transverse "cleavage."*

† Supplementary Note to a Paper entitled "Researches in Embryology. Third Series: a Contribution to the Physiology of Cells." Philosophical Transactions, 1841, Part II. p. 193.

‡ When the *longitudinal* striæ are exceedingly distinct, the fasciculus does not "break off short." This appears to be owing to the absence now of the investing spirals; which, when present as such, regulate the direction of the fracture. I have already stated them to pass into a membranous form.

§ Occasionally the extremities of the ruptured spirals (figs. 156, 157) may be seen pendent at the part where the fasciculus is broken off or notched.

120. A late observer seems to have regarded the interlacing spirals, now mentioned, as "the edges or focal sections of plates or discs, arranged vertically to the course of the fasciculi, and each of which is made up of a single segment of every fibrilla†." He seems to have mistaken the normal appearances of interlacing spirals, for disturbed states of his supposed "discs." The minute anatomy of the tissues is to be learnt in no other way than by tracing them from their earliest origin.

121. I have in no instance delineated muscle that had undergone maceration, a process open to objection, because putrefactive changes may cause the more delicate portions of a structure to disappear. Can the alleged "beaded" structure of the fibril (which I have never been able to see in *recent* muscle) be demonstrated *without* maceration?

122. This may not be an improper place to draw the attention of future observers, generally, to the effect produced by corrosive chemical reagents, as well as by maceration: whether the maceration be continued so as to produce putrefaction or not. It is easy to imagine that, owing to the operation of either of these, a delicate structure may be entirely destroyed, and therefore unrecognized; or its continuity separated into isolated parts. And I cannot but think that it must be from some such cause as this (the disintegrating effect of prolonged maceration), that Bowman exhibits the fibril of muscle as consisting of beads‡, while my own observations represent it as consisting of a double spiral: and that there is so great a difference between his explanation and my own, of transverse "cleavage." It is true that I also have had recourse to the use of chemical reagents. But there is a wide difference between *the presence* and *the absence* of a visible object immediately after the application of a chemical reagent, when the *peculiar form* of that object entitles it to be considered, not as a chemical compound, but as an organized structure (par. 95).

123. Observers appear not to have determined the mode in which the "fibres" contained in hairs have their origin§. Young hair (wool) of the fœtal sheep presented to me the appearance, an outline of part of which is sketched in fig. 155. The hair-bulb contained nuclei, which seemed to be unwinding, watch-spring-like, into "fibres," that is, flat, grooved, and compound filaments (α), which I have already mentioned having seen in hair (par. 71). These filaments, immediately after being given off from the nuclei, appeared to *interlace*. In the shaft they presented very much the same appearance as those in the olfactory nerve (fig. 108). The interlacing of the filaments produces very remarkable appearances in the shaft of many hairs, as those of the Mouse, Mole, and Rabbit.

† Bowman, *l. c.*, p. 469.

‡ As in "three fragments of a macerated heart." Bowman, *l. c.*, Plate XVI. fig. 17.

§ See Simon, in Müller's Archiv, 1841, Heft IV. p. 369: by whom the researches of Henle, and those of Bidder are referred to.

124. At the commencement of last year, I presented to the Society a communication, in which certain appearances I had noticed in blood-corpuscles were referred to a process of the same kind as that previously described by myself, as witnessed in the germinal vesicle, that is, in the essential part of the ovum. I concluded, that the corpuscles of the blood are generated by a process of the same kind as that giving origin to those cells which are the immediate successors of the germinal vesicle, or original parent cell. The comparison, however, was not then extended beyond the mode of production of young cells.

125. My subsequent researches show that we may go farther. The changes taking place in the ovum lead to the formation of a new being. Those effected in the corpuscle of the blood lead to the formation of a filament, endowed with the property of reproducing itself by division. And what is very remarkable, the position of this filament in the blood-corpuscle bears a striking resemblance to that of the young in the ovum of certain intestinal worms, as remarked by Professor Owen, on seeing my drawings of the filament in corpuscles of the blood†. Is the blood-corpuscle to be regarded as an ovum?

126. Explanation of the Plates.

PLATE V.

Fig. 1. Man. Blood-corpuscles, in blood obtained by a puncture of the finger. Each of them has become a filament, having a coil-like form (par. 1).

Fig. 2. Man. Blood-corpuscles, in blood (obtained by a puncture of the finger) which had stood for some time, between two pieces of glass, in the microscope. Each of them is now a more or less coiled filament. The division of the blood-corpuscle into very minute objects (discs), which may be seen taking place in the microscope, seems to be preparatory to the formation of the filament (par. 25).

Fig. 3. Man. From the coagulum of venous blood, taken in hæmoptysis. α. Filaments, for the most part parallel. β. Blood-corpuscle which has passed into a coiled filament (par. 8).

Fig. 4. From the same coagulum. α. Filaments; β. Rings; γ. Coils, and other objects; all of them altered blood-corpuscles, having the same structure as the filaments α. The whole blood-red. The buffy coat in other blood presented similar filaments, in denser aggregation, and less red (pars. 8, 97).

Fig. 5. Sparrow (*Fringilla domestica*, Linn.). Sketch of blood-corpuscles, each presenting a coiled filament. The figure represents the *structure* of the filament at α (par. 13).

† I have already mentioned that the appearance of some of the blood-corpuscles when exhibiting changes in their form, is such as to suggest the idea of a filament being contained within them.

Fig. 6. Sparrow. From the coagulum of blood. α, β. Blood-corpuscles (coils) unwinding themselves into the straight and parallel filaments of the coagulum (par. 8). The filament β is on its edge (par. 6).

Fig. 7. Chick (*Phasianus Gallus*, Linn.) *in ovo*, incubated twelve days. Sketch of blood-corpuscles (coils), which are unwinding themselves as filaments. α. Parallel filaments, in the same field of view. Blood-red. From the wing. Similar objects seen in the leg (par. 8).

Fig. 8. Turtle. Sketch of blood-corpuscles containing filaments. In all of these corpuscles, the filament is *formed* at the outer part. Between this outer part and the centre, the corpuscles α, β present discs arranged in lines for the formation of a further portion of the filament (par. 25). In the coagulum of blood of the Turtle, the same unwinding of corpuscles into filaments was seen, as is described in the explanation of fig. 10. from the Newt, and in other figures.

Fig. 9. Frog (*Rana temporaria*, Linn.). Sketch of blood-corpuscles containing filaments. α. Even the central part is unwinding itself into a filament. β. Exhibits a spiral arrangement of the filament. γ. Filament on its edge at one part: indistinct at other parts in this corpuscle. δ. Discs, also, seen in this corpuscle: their outer part having very much the appearance of a filament.

Fig. 10. Newt (*Lissotriton punctatus*, Bell.). Sketch of blood-corpuscles containing filaments, which are represented only in certain parts. α. The nucleus is double (pars. 98½, 99). β. The outer part of the nucleus resembles that of a ball of twine, from its consisting of a filament. γ. The nucleus unwinding itself into a filament. δ. The filament on its edge (par. 6). ε. Nucleus removed from its corpuscle. It is unwinding itself into a filament. ζ. Corpuscle giving off a filament from its outer part. η. Filaments, some of them parallel, into which some of the corpuscles have passed. This blood had stood for a while in the microscope (par. 8).

Fig. 11. Toad (*Rana Bufo*, Linn.). Sketch of blood-corpuscles containing filaments. α. The coil-like form of the filament is seen. β. Represents the outer portion of the filament lying on its edge; and rendering this part of the corpuscle thicker than that immediately internal to it; as well as giving to the corpuscle the appearance of being abruptly cut off (par. 2). γ. In a condition less advanced than α: there being in γ more of the central part still in the state of discs (par. 2).

Fig. 12. Skate (*Raia batis*, Linn.). Sketch of blood-corpuscles, each containing a coiled filament. This filament on its edge at the circumference (see the explanation of γ, fig. 11 and par. 2).

Fig. 13. Cod (*Gadus Morrhua*, Linn.). Sketch of blood-corpuscles more or less advanced in giving origin to filaments. α. The formation of the filament is

far advanced; β. the outer part is formed, nucleus double (pars. 98½, 99); γ. no part of the filament yet formed; but discs are arranged in a line for its formation (par. 25).

Fig. 14. Lobster (*Cancer marinus*, Linn.). Sketch of blood-corpuscles, each of which has become a coiled filament (par. 4). α. Structure of the filament (par. 6). At β the filament is on its edge.

Fig. 15. Oyster (*Ostrea edulis*, Linn.). Sketch of blood-corpuscles, each of which has become a coiled filament (par. 4). At certain parts the figure represents the structure of the filament (par. 6).

PLATE VI.

Fig. 16. Rabbit (*Lepus Cuniculus*, Linn.). Sketch of blood-vessels in the pia mater α. Longitudinal filaments, merely dotted in, except that on the left, which represents the structure of the filament (par. 6). β. Outline of a filament spirally investing the longitudinal filaments. γ. Structure of this filament. δ. Blood-corpuscles, chiefly young and of very minute size. ε. Line marking the situation of the inner surface of the vessel (par. 64).

Fig. 17. Rabbit. From the spinal chord. Corpuscles, apparently young blood-corpuscles (α), passing into a compound disc (β), out of which there is formed either a ring (γ) or a coil (δ). The larger coils ε, ε, seemed to be advanced conditions of γ and δ. Colour red (par. 34).

Fig. 18. Rabbit. Sketch of bodies observed in the retina. The general appearance of such bodies is that of rings, having a very high refractive power ("globules" of authors?). But they are coiled filaments, often seen to be formed out of rings such as those in fig. 17. Such objects are red (par. 34).

Fig. 19. Rabbit. From the medullary substance of the brain. Ring-like object or coil, connected, certainly at α and probably at β, with a filament, the structure of which is seen at γ. Blood-red (par. 34).

Fig. 20. Sheep (*Ovis Aries*, Linn.). From the grey substance of the cerebellum. Sketch of coils, which are altered discs, such as β fig. 17 (par. 34).

Fig. 21. Sheep. From the spinal chord†. Coils, arisen out of discs having the appearance of blood-corpuscles. α Was lying on β, and apparently entering, with it, into the formation of a tube (see pars. 34. 35). γ. Structure of the coiled filaments.

Fig. 22. Sheep. From the spinal chord†. Objects such as those in fig. 21 having united to form a tube (α), other spirals come into view in the interior (which indeed are represented in fig. 21). The continually renewed nuclei, unwinding themselves, first in one direction and then in the other, give origin to coils, the adjacent extremities of which unite, and then form

† White substance from the interspace between the posterior and lateral tracts.

spirals. The last formed, or forming, of these spirals is seen at β, together with its structure. γ. Represents the nuclei. Spirals were noticed between α and β, but they are not represented in the figure (pars. 35, 38).

Fig. 23. Chick *in ovo*; twelfth (?) day of incubation. Sketch of a muscle-tube. α. Membrane. β. Nuclei in the centre of the tube: very near together. γ. Spiral. δ. Another spiral appearing to arise from some of the nuclei. See the description of fig. 22 β.

Fig. 24. Rabbit. From the cortical substance of the cerebrum. Blood-red cell arranged to form tubes. These cells are in outline excepting two, in which the contents were seen to consist of discs, or ring-like objects, arranged with regularity, like those in muscle, fig. 45.

Fig. 25. Sketch of mould on a ripe berry (*Rubus fruticosus*, LINN.) that had been kept a few days. Cells having arranged themselves in a necklace-like form, have elongated, and spirals are forming in their interior (par. 67).

Fig. 26. Sketch of mould from cheese. α. Granules, escaped from containing bags. β, β. Tubes, still exhibiting the *septa* between the cells, by the union of which they were formed. One of them is branched. At γ, in one of the tubes, are cell-like objects arranging themselves in lines. δ. Rings now visible. ε. Smaller rings, or interlacing spirals. ζ. Spirals having been formed, they have become very much elongated, so as to appear nearly horizontal (par. 67).

Fig. 27. Mushroom. Sketch of germinal granules, of a reddish brown or purple colour, from the hymenium. In such granules a nucleus is seen, often consisting of two parts. Around the nucleus are other objects, smaller and having a less refractive power. These are not represented, except in α. β. Granule, apparently younger than the rest (see par. 90).

Fig. 28. Tadpole, about $5'''$ or less. From the tail. Outline of cells, which are altered blood-corpuscles, arranged in a line to form the first muscle-cylinder or tube (par. 42).

Fig. 29. Tadpole, about $5\frac{1}{2}'''$. From the tail. Corpuscles having the appearance of young blood-corpuscles, as viewed along with many others in a group, apparently escaped together by the rupture of one parent corpuscle. Cells such as those in fig. 28 are filled with young corpuscles or discs, apparently of the kind represented in the present figure (par. 42).

Fig. 30. Tadpoles, $4\frac{1}{2}'''$ to $5'''$. From the tail. Fragments consisting apparently of the contents of objects such as those in fig. 28; the discs (fig. 29) in which have arranged themselves in columns. The fragments are for the most part in outline, except β. γ Presented a membranous appearance at the surface, not seen in α and β. α Was of such length as to appear like two of the cells in fig. 28, not separated from one another. δ. Appearance presented by one of the compound discs in the columns (par. 42).

Fig. 31. Tadpole, $4\frac{1}{2}'''$. From the tail. Compound discs resembling those in figs. 29 and 30. The adjacent ones seemed to have united at a certain part, so as to produce a spiral form. The two bodies in this figure appear to be two columns such as those in fig. 30 (par. 42).

Fig. 32. Tadpole, $5'''$. From the tail. Tubes the parietes of which consist of spirals, forming out of discs such as those in fig. 31 (par. 42).

Fig. 33. Tadpole. From the tail. More advanced stage of the same kind of tubes (par. 42).

Fig. 34. Mould, found on the left auricle of a sheep, several days dead. It is almost entirely in outline. The figure represents two parallel and contiguous tubes; each tube lined by what appeared to be smaller tubes. The divisions between the latter are shown by dots. Within the *larger* tubes, there were highly refracting globules (see the figure), varying much in size, and some of them, when first seen, were easily moved in the longitudinal direction of the tube. They probably were contained in a fluid. Within the smaller tubes on the left hand, were seen either rows of discs (γ), or filaments (β). The smaller tubes on the right hand (α) presented a central cavity; these being probably more advanced than the tubes at β and γ.

PLATE VII.

This Plate represents the Formation of Muscle.

Figs. 35 to 44. Chick *in ovo*; incubated twelve days. Early stages in the formation of muscle, from various parts of the body. Very much in outline.

Fig. 35. There are seen parietal nuclei, with orifices in them: these orifices corresponding to the "nucleoli" of authors. At α, the discs are arranging themselves in a spiral form even around the orifice, *i. e.* as soon as formed. A large spiral invests the whole.

Fig. 36. The figure represents the central part of a tube (α) and a spiral (β). At the outer part, in α, are longitudinal filaments. The spiral β surrounded these filaments. The inner part of α is occupied by cells. Each cell has a highly refracting nucleus, and is filled with discs. The nucleus in each cell has an orifice ("nucleolus").

Fig. 37. Mere outline. The nuclei have positions different from those of the nuclei in fig. 36.

Fig. 38. Some of the filaments contained in the tube present their edges, others their flat surfaces to the observer. In the middle of the tube there are nuclei, small and in near approximation. The tube is flat.

Fig. 39. α. Spiral filament. β. Longitudinal filament; parallel to which, are others of the same kind in outline. γ. Nucleus divided into several parts (discs).

Fig. 40. More advanced state of apparently corresponding objects; the filaments enlarged.

Fig. 41. α. The points of contact in the spiral threads, which constitute the filament, beginning to separate. β. This separation more complete (par. 27).

Fig. 42. Appearances, in three instances, of the nuclei in muscle-tube. The dots show merely the breadth of these tubes. We have here evidence of division (α) and subdivision (β) of the nucleus, with a diminution in its size (par. 42). Filaments were very distinct in the tube β.

Fig. 43. Sketch showing some displacement of filaments by the nucleus; and slight enlargement at this part in the breadth of the tube. It is the edges of the filaments that are seen in this figure.

Fig. 44. α. Nuclei and spirals contained in a tube. β. Another part of the *same tube*: its diameter greater; and this part filled with discs, the arrangement of which was regular (pars. 22, 42). These discs quite red, and resembling young blood-corpuscles (par. 42).

Fig. 45. Chick *in ovo*; incubated twelve (?) days. Outline of the extremity of a muscle-tube, and its contents. These were discs, having precisely the same appearance as young blood-corpuscles (par. 42); and they were arranged with great regularity (pars. 22, 42) in the tube (see the explanation of fig. 48).

Fig. 46. Tadpole, $5\frac{1}{2}'''$. From the tail. Muscle-tube containing discs having the same appearance as young blood-corpuscles (par. 42), each of which exhibited bright points near the centre, these denoting the situations of future discs (par. 44).

Fig. 47. Turtle. Muscle-tube from the heart. The tube contains rings linked together, and preparing to form interlaced spirals (pars. 22, 42).

Fig. 48. Tadpole, $5\frac{1}{2}'''$. Muscle-tube. From the tail. α. Rings, arranged with great regularity in the same way as the discs in figs. 45 and 46. β. Structure of the rings. γ. Spirals formed out of such rings (pars. 22, 42). δ. Structure of the spirals. Each ring appeared to contain the elements of future rings (par. 44), not represented in the figure.

Fig. 49. Tadpole, $5\frac{1}{2}'''$. Muscle-tube, in which are seen interlacing spirals, each of which surrounded minuter objects (filaments ?).

Fig. 50. Tadpole, about $5'''$. Muscle-filament ("*fibril*") on its flat surface. It measured in breadth $\frac{1}{1000}'''$ (par. 45).

Fig. 51. Young Monoculus. Flat surface of a muscle-filament ("fibril"), observed in the leg, near its extremity (par. 45).

Fig. 52. Turtle. From the heart. Muscle-filament ("fibril") on its flat surface (par. 45). At the lower part the two spiral threads composing it have become unconnected. One of these threads still presents the spiral form.

Fig. 53. Chick *in ovo*; incubated fifteen days. From the leg. Filament, seen with an immense number of other filaments, forming a very large muscle-fasciculus (par. 45).

Fig. 54. Periwinkle. Interlacing spirals. The lower part of α was not very distinctly seen on the left side. β. Similar objects, but larger. They are in outline. γ. Seen with great distinctness (par. 45).

Fig. 55. Scheme, illustrating the structure, apparently, of the objects figs. 40 α, 41 α, β, 52, 54, 56, 83, 84, and of every object termed in this memoir a filament, flat filament, or band, *i. e.* a "fibre" (pars. 13, 14).

Fig. 56. Turtle. Portion of muscle from the heart. It is a filament, composed of two interlaced spirals (par. 45); but very much larger than usual. At α the filament is broadest: at β it is narrower, perhaps from elongation: at γ it is twisted; and it is the (narrow) edge of the filament that is here seen (par. 44 Note).

Fig. 57. Chick *in ovo*; incubated fifteen days. Interlacing spirals. α. Two nuclei, with orifices ("nucleoli"), in the space circumscribed by one of the spirals (par. 44).

Fig. 58. Tadpole, $5\frac{1}{2}'''$. Four spirals visible on one side of the fasciculus; in each of which were seen two filaments (par. 42). An appearance of fibres crossing one another (spirals entering into the formation of the investing membrane?) was observed at the outer part. They are not shown in the figure.

Fig. 59. Tadpole. From the tail. A small muscle-fasciculus, in which are seen spirals surrounding objects, probably filaments, too minute to be examined in this state. On the left side, one of the spirals is ruptured. (par. 42).

Fig. 60. Scheme, showing the structure of objects illustrated by fig. 55, in an altered state (see pars. 27, 38, 39).

Fig. 61. Muscle-filament ("fibrilla") from the iris of a fish, on its flat surface (par. 45).

Fig. 62. Tadpole, about $6'''$. Sketch of the widened or brush-like extremities of two ruptured fasciculi of muscle (par. 119 Note.) α. Two filaments ("fibrillæ"). The inner of these filaments presents its edge only. The outer filament exhibits at the upper part, its flat surface; and at the lower part, its edge: *i. e.* this filament is twisted (par. 45.). Dots represent the situations of the other filaments in these two fasciculi.

Fig. 63. Tadpole. Sketch of a fasciculus of muscle, broken off at the upper part. The transverse and longitudinal striæ, are represented by lines, except at α, where the structure is delineated fully. This part shows the edge of six filaments ("fibrillæ") (par. 45). β, β, β. These longitudinal striæ darker than the rest (par. 42).

Fig. 64. Muscle; α, γ, from the Lobster (after boiling); δ, from the Sheep. α, γ. Interlaced spirals, which are compound filaments. Their structure is seen at β. Dots represent the situation of longitudinal filaments, surrounded by the spirals α, γ. δ. Appearance inducing the belief that the transverse striæ cross the fasciculus in a continuous line, until the parts are more minutely examined (see the objects α, γ, and par. 120).

Fig. 65. Tadpole, $8'''$. From the tail. Muscle-fasciculus more advanced than that in fig. 94. It presents on one side four interlacing spirals; each spiral a compound object. Their contents not shown.

Fig. 66. Young Crab. Two portions of a fasciculus of muscle; α. Contracted; and β, relaxed (see par. 52). The arrow shows the longitudinal direction of the fasciculus.

Fig. 67. Tadpole. Two portions of a fasciculus of muscle. α. The edges of four filaments ("fibrillæ") are seen, unchanged. β. Extremity, elongated to a point before being broken. In β, the direction of the spirals is very much altered. The upper part of β may serve to convey an idea of the state of a fasciculus in extreme relaxation (par. 51). β Appeared to be invested by a highly elastic membrane (par. 54). The extreme point of β was at the distance of $\frac{1}{11}'''$ from α.

PLATE VIII.

Fig. 68. Tadpole, $5\frac{1}{2}'''$. From the tail. Appearance near the surface of an object such as the larger of those in fig. 73, after the addition of acetic acid of the strength of distilled vinegar. The discs it presented (fig. 68) seem to have been the essential part of spirals such as the larger of those in fig. 73; the outer part of which had been removed by the acetic acid. α. The discs seemed to be composed of minuter discs (par. 55).

Fig. 69. Tadpole, about $5'''$. From the tail. Spirals detached from a fasciculus of muscle; in a quadruple coil (par. 80).

Fig. 70. Tadpole, about $5'''$. From the tail. Spirals detached from a fasciculus of muscle; in a double coil (par. 80).

Fig. 71. Strawberry (*Fragaria vesca*, Linn.). Spiral from the leaf-stalk. This spiral is a compound object, containing filaments ("fibres") (par. 80).

Fig. 72. Sheep. From the white substance of the cerebellum. A spiral filament. α. Structure of this filament (par. 35).

Fig. 73. Tadpole, $5\frac{1}{2}'''$. From the tail. Sketch of two sets of spirals; several being parallel in each. The spaces circumscribed by these spirals presented discs; and the spirals exhibited more or less distinct traces of discs in their substance (par. 55).

Fig. 74. Flax, dividing and subdividing into filaments ("fibres"). At α, and in part of β, a membrane-like investment prevented the structure from being seen (pars. 69, 62).

Fig. 75. Similar division of flax. The same fasciculus presented the three states α, β, γ (par. 69).

Fig. 76. Similar division of flax; the states α, β, γ and δ, having been seen in the same fasciculus (par. 69).

Fig. 77. Sheep. From the spinal chord†. Sketch of a fasciculus of nerve. At α, a spiral crosses the entire fasciculus: at β, one half of the fasciculus is crossed by another spiral (par. 39).

Fig. 78. Sketch of mould from a ripe berry (*Rubus fruticosus*, Linn.). It presents a fasciculus of filaments, surrounded by a spiral filament (par. 67).

Fig. 79. Tadpole, about 5‴. Portion of muscle. From the tail, presenting interlaced spirals (par. 45). These are more transversely curved at the upper part, and the object (filament) is therefore wider here than below, where the direction of the curves is more oblique. At a part still lower than the figure shows, the object was as broad as at the upper part of the figure: and here also there was a corresponding change in the direction of the spirals (par. 51).

Fig. 80. Sheep. From the spinal chord†. Sketch of spiral filaments (α), surrounding filaments having a more (yet not perfectly) longitudinal direction (β). Internal to the latter, was a broad "band-like axis" (γ), exceedingly delicate, and consisting of very minute filaments, such as those in fig. 81. (par. 36).

Fig. 81. Sheep. From the spinal chord†. α. Dots, showing the curves of a spiral. These curves presented great irregularity in their direction, which has not been imitated in the figure. β. Delicate "band-like axis" (corresponding to that in fig. 80), consisting of minuter filaments. Spirals seen in the latter (par. 36).

Fig. 82. Sheep (?). From the grey substance of the cerebellum. Sketch of a fasciculus of nerve, consisting of two halves. Two spiral filaments are seen, the one surrounding half of the fasciculus, and the other surrounding the whole of it. The latter spiral is removed from the fasciculus at the lower part (par. 39).

Fig. 83. Sow Thistle (*Sonchus oleraceus*, Linn.). From the root. Sketch of two interlaced spirals, invested by something like a membrane (par. 83).

Fig. 84. Tadpole. Sketch of two interlaced spirals in muscle, forming a very large filament (par. 45). Between α and β, the filament is twisted; presenting here, therefore, a thinner part, its edge.

Fig. 85. Sheep. From the spinal chord†. Sketch of a fasciculus of nerve. The upper

† See the note, p. 120.

or outer part α, is in mere outline. The lower or inner part appeared to correspond to that marked γ in fig. 80, and β in fig. 81; but was in a more advanced state, the filaments (very minute and delicate in figs. 80 and 81) having enlarged, and separated from one another. The spirals in these filaments are represented at certain parts (β) (par. 36).

Fig. 86. Sheep. From the spinal chord†. Sketch of filaments. They represent a state more advanced than those in fig. 85 (β) (par. 36).

Fig. 87 to 90. From the root of the Sow Thistle. Most of the objects represented in these figures, have the appearance of being merely "dotted," when viewed at certain distances (par. 83).

Fig. 87. The tubes sketched in this figure were filled with interlaced spirals, which are represented only at certain parts. In the tube α, the direction of these spirals is unaltered. In β, partly separated from the other tubes, the spirals have been distorted; precisely the change that takes place in muscle (par. 54). γ. Extremity of the tube β, elongated to a point, with a corresponding elongation of the contained spirals. Compare with fig. 67, from muscle, and see the description of fig. 67.

Fig. 88. Corresponding tube, in a state more advanced, and the spirals, therefore, more numerous and smaller. α. Surface of the tube ("dots"). β. Interior (par. 83).

Fig. 89. α. Interlaced spirals, nearly resembling those in fig. 87. β. Interlaced spirals in a distorted state (par. 54). γ. Drawn by reflected light, exhibits interlaced spirals. Compare with figs. 92, 93, and 94, from muscle.

Fig. 90. The tube in this figure presents the appearance, merely, of transversely elliptical, and bright "pores" or "dots;" which in reality are spaces between the curves of interlacing spirals, such as those in figs. 87, 88, and 89, the curves being concealed in fig. 90. The more superficial of the spirals in fig. 90, seem to be coalescing into a membranous substance, which conceals the inner ones. α. One of the "*septa*," formed by the interlacing spirals (par. 83).

Fig. 91. Sheep. Filament consisting of interlaced spirals, from the cornea. The cornea appeared to be wholly composed of filaments in the densest aggregation, and running in every direction.

Fig. 92. Turtle. Interlaced spirals, from the heart.

Fig. 93. Chick *in ovo*; incubated fifteen days. α. Sketch of interlaced spirals in muscle. On the right, at the lower part, are portions of a ruptured spiral, adherent to the rest. The object β represents a young fasciculus of muscle. Compare it with fig. 89 γ, and see par. 83.

† See the note, p. 120.

Fig. 94. Tadpole, about $5'''$. From the tail. Young muscle-fasciculus, presenting on one side three interlacing spirals, with their contents. This object very much resembles β of fig. 93, but is larger. The alternation of the inner spirals in a large fasciculus, may be seen by gradually shortening the focal distance.

Fig. 95. Tadpole, $5\frac{1}{2}'''$. Superficial part of a muscle-fasciculus presenting interlaced spirals (par. 42).

Fig. 96. Tadpole, about $6'''$. Muscle-fasciculus presenting on one side five interlaced spirals (par. 42). The transverse striæ somewhat distorted by manipulation.

PLATE IX.

Fig. 97. From mould formed on a portion of the heart. α. Tube containing filaments, apparently spirals, running in different directions, and crossing one another. The filaments are dotted merely. It is their edges which are thus represented. β. Tube containing interwoven spiral filaments, in outline except at one part (par. 67).

Fig. 98. From the same mould. The figure represents two parts of a tube, containing filaments. In the part α, some of the filaments are very longitudinal; others more spiral, and interlacing. In the part β, the spiral filaments (δ) are more *transversely* spiral: they seemed to have been broken off at this part, and had perhaps recoiled in consequence (par. 39). At γ, are filaments transversely spiral; and forming a narrow mass, occupying only the middle of the tube. δ. Structure of the filaments.

Fig. 99. Sheep. From the spinal chord†. Fasciculus of nerve. The figure represents only a part of the many spiral filaments seen in this object. Between some of these spiral filaments (α) were enlargements (β). γ. Structure of the spiral filaments, as well of those at α, as of the others. δ, δ. Longitudinal filaments. ε. Central space, much more pellucid than the rest. This central part is the place of origin of new substance. There seemed to be in the interior, filaments interlacing with one another. These are not represented (par. 39).

Fig. 100. Sketch of fasciculi of flax. In α, are seen longitudinal and spiral filaments. In β, the filaments seemed to interlace (par. 68).

Fig. 101. Sketch of a fasciculus of flax; the interior not shown. Here and there, and in some degree at pretty regular distances, it was crossed by transverse filaments running in opposite directions. At α, there were two of these filaments in each direction (par. 68); at β, there was only one. Where these filaments (α and β) were situated, the diameter of the fasci-

† See the note, p. 120.

culus was greater than elsewhere, independently of the presence of the filaments (α and β). In some parts a single transverse filament crossed the fasciculus, without being met by one in the opposite direction.

Fig. 102. Sketches of fasciculi (the "primitive fibres" of authors) in the ischiatic nerve. All that is intended by this figure, is to show the breadths of the fasciculi, and to give some idea of the direction of such of the contained filaments ("white substance," par. 28) as are represented, which is by no means all that were present in these objects. α and γ. Filaments interlacing. β. Filaments more longitudinal. In β, the interior seemed fluid, or nearly so.

Fig. 103. Chick *in ovo*; incubated twelve days. Very young muscle-tube in a state resembling that in fig. 111 (see the description of fig. 111). The longitudinal filaments are all represented by dots except one, which is seen on its flat surface. The spiral filament is in outline.

Fig. 104. Sketch of a fasciculus of filaments from mould on a ripe berry. The same mould as that in fig. 78.

Fig. 105. Sheep. Sketch, showing the diameter, and undulating, soft appearance of two of the fasciculi in the medullary substance of the cerebrum. In one of these, some of the contained filaments are represented.

Fig. 106. Sheep. Sketch of fasciculi from the cortical substance of the cerebrum, wholly composed of filaments. One of these fasciculi, α, is in outline only. In the other, β, filaments are represented; but these are merely dotted in, with one exception, γ. These filaments did not appear tense, but of the same softness as those from the olfactory nerve, fig. 108. δ. Division of the fasciculus into two parts.

Fig. 107. Rabbit. Fasciculus from the optic nerve. It consists of filaments, lying loosely together, and less distinctly circumscribed by a membranous investment than those of the "white substance" in, for instance, the ischiatic nerve (par. 32).

Fig. 108. Rabbit. Fasciculus from the olfactory nerve. See the description of fig. 107, which is quite as applicable here. The appearance is well represented in this figure (par. 32).

Fig. 109. Sketch of a fasciculus of flax. It represents very few of the filaments seen in the interior. α. Membrane at the surface divided at this part. β. Filament having a longitudinal direction. γ. Direction of more oblique filaments. ε. Central body, surrounded apparently by a fluid. In other parts of the fasciculus, ε was not visible. *It appeared to have resolved itself into the interlaced filaments fig.* 110; *each of the threads in* ε *producing several filaments.*

Fig. 110. Part of the same fasciculus of flax as that in fig. 109. α. Division of an investing membrane. In the interior were interlaced, and apparently

spiral, filaments, probably arisen out of part of ε fig. 109. See the explanation of fig. 109. Several of these filaments are represented in the figure, and parts of others are shown in outline. These filaments were tense. The direction of β seemed longitudinal.

Fig. 111. Chick *in ovo*; incubated twelve (?) days. From the leg. A very young muscle-tube in which there are seen five filaments. The figure represents the edges of these filaments. Two of them are close together, and so applied as to produce almost transverse striæ; three are loosely situated in the tube. Such filaments appear to become enlarged into such as those in figs. 40, 41.

Fig. 112. Frog. From a nerve of the leg. α, β. Fasciculi or tubes (the so-called "primitive fibres"). In α, is seen one of the filaments ("white substance," par. 28) which lie loosely together in these tubes. This filament is on its flat surface. Dots indicate the situation of other filaments. In β are represented four of these filaments, all on their edges. The direction of three is oblique. γ. Filament, the structure of which was remarkably distinct. δ. Similar filament, but more minute and on its edge. γ and δ seen in fasciculi such as those at α and β.

Fig. 113. Sketch of a fasciculus of flax. α. Spiral, composed of two filaments, the structure of which is seen at the extremity. Compare with α α of the present figure; with spiral from the leaf-stalk of the Strawberry, fig. 71; with that in flax fig. 101; with those in muscle, figs. 69, 70; and see par. 80 on the reproduction of spirals by division. α α. Spiral running in the opposite direction; and consisting of *four* filaments (see the reference above). The filaments surrounded by the spirals α and α α, are seen for the most part on their edges, in the figure. They have the same structure as the filaments of the spirals α and α α. A cavity in the middle of the fasciculus. Acetic acid.

Fig. 114. Rabbit. Filaments found in the retina. The number seen was very great. α. Is on its edge. β. The upper part on its edge; the lower on its flat surface (pars. 6, 14).

Fig. 115. Rabbit. Filaments from the medullary substance of the cerebrum. α. On its edge; β. on its flat surface (pars. 6, 14).

Fig. 116. Rabbit. From the cortical substance of the cerebrum. β, γ. Filaments, the former on its flat surface, the latter on its edge (pars. 6, 14).

Fig. 117. Frog. From the spinal chord. α, α, β. Filaments; α, α, on their edges; β. on its flat surface (pars. 6, 14). γ. Varicose object, the enlargements often at pretty equal distances. I have seen the pellucid central part (nucleus?) of one of these enlargements to run along the object, and pass into another enlargement, which was thus increased in size.

Fig. 118. Rabbit. Sketch of an object noticed in the lachrymal gland (see par. 40).

α. Interlacement of filaments. β. Structure of these filaments. γ. Spirals. δ. Their structure. ε. Outline of trunk; into which ζ passed.

Fig. 119. Advanced state of such an object as ε, fig. 109.

PLATE X.

Fig. 120. Tadpole, about $5\frac{1}{2}'''$. Corpuscles, having the same appearance as young blood-corpuscles, connected like the links of a chain (par. 23).

Fig. 121. Tadpole, about $6'''$. Sketch of muscle-tubes, as seen lying together, several of them exactly parallel, and the whole apparently discharged from a parent structure (par. 42). No more than the most superficial portion of their contents is shown; and this only at certain parts. Some of these tubes (α) present at least two spirals; in another (β) are interlaced spirals; and in a third (γ), there are rings for the formation of interlacing spirals (par. 42). Very weak acetic acid.

Fig. 122. Tadpole, $5\frac{1}{2}'''$. Similar tubes. α. The direction of the spirals is exceedingly oblique. β. Interlaced spirals. δ. The number of spirals appears to be three.

Fig. 123. Tadpole, $5\frac{1}{2}'''$. From the tail. Muscle-fasciculus in which the objects γ are surrounded by spirals, β, in such a manner, that each γ is shared by two of β. α. Larger spiral, common to the foregoing (par. 54).

Fig. 124. Tadpole. Muscle-tube representing different states of the more central (α, β), as well as the conditions of the more superficial (γ, δ) parts. α. Discs not in lines. β. Larger discs, near the centre, and in something like lines. γ. Discs overlapping one another, and in some parts appearing as if linked together. These more superficial than the discs β, and nearly on a level with the interlaced spirals δ; which correspond to γ of fig. 48.

Fig. 125. Turtle. From the heart. Sketch of interlacing spirals. Each spiral is a flat and compound filament; the edge of which filament is directed towards the observer. Every spiral *thread* appears to contain nuclei; and may therefore become a compound filament (par. 55).

Fig. 126. Dandelion (*Leontodon Taraxacum*, Linn.). Sketch of a portion of the pappus. Longitudinal filaments (β) in the interior are represented by dots. These filaments are collected into fasciculi by spiral filaments (α); the longitudinal filaments being represented by rows of dots, their structure is shown at γ.

Fig. 127. Groundsel (*Senecio vulgaris*, Linn.). From the root. α, β. Sketch of filaments. The structure seen in certain of them. γ Represents the structure of the filaments β, and their larger size.

Fig. 128. Nettle (*Urtica dioica*, Linn.). The figure represents, between α and β, the breadth of a hair from the leaf-stalk; and filaments on the inner sur-

face of the hair. γ. Structure of the filaments, and frequent position with reference to the surface. The dots show merely the direction of other of the filaments: this direction being spiral. Their distance from one another is different in different hairs. A similar appearance observed in hairs from the under surface of the leaf and from the stem (par. 72).

Fig. 129. Fœtal Sheep. From the crystalline lens. Sketch of tubes containing discs. A space in the middle of the tubes (see par. 61).

Fig. 130. Chick *in ovo*; incubated fifteen days. From the crystalline lens. Chiefly in outline. α. Composed of filaments, two of which are represented in the figure. β. An object composed of filaments, more of which were present on the right hand than on the left; whence the greater thickness at the former part. The arrow indicates the longitudinal direction of these filaments. At one end of this object (β) are pendent portions, not of entire filaments, but of spiral threads composing filaments; these spiral threads hanging from the extremities of certain filaments where broken off. γ. Portion of a fasciculus of filaments containing a nucleus, which displaces the contiguous filaments. Many such fasciculi are seen in fig. 132. In the nucleus are three discs, with an orifice in each.

Fig. 131. Bream. From the central part of the crystalline lens. α. Two spirals running in opposite directions, the one within the other. β. Two interlaced spirals containing filaments. γ. Two interlaced spirals. δ. Filament enlarging. Certain states of filaments pass into the toothed fibre, discovered by Sir David Brewster (see par. 62).

Fig. 132. Chick *in ovo*; incubated fifteen days. From a more central part of the same lens, as that from which fig. 130 was taken. Sketch of a flat object, folded at β. It was composed of fasciculi, γ, resembling γ of fig. 130. These fasciculi consisted of filaments, among which were nuclei, displacing, as at α, the contiguous filaments.

Figs. 133 to 136. Rabbit. From the cartilage of the ear.

Fig. 133. This figure represents in outline the situations of several cells. The nuclei of these cells are not shown in all of them. In one instance, α, the nucleus resembles a ball of twine (see par. 18). β. Some of the filaments of the intercellular substance. The nucleus frequently elliptical in form.

Fig. 134. Cell, for the most part in outline. The walls composed of interlaced filaments. α. Structure of the filaments. The central portion of the nucleus had divided into two parts (centres), held together in a remarkable manner by interlaced filaments, proceeding from these parts. Possibly this division of the nucleus denotes incipient division of the cell into two minuter cells. Each of the two parts (centres) of the nucleus had its orifice ("nucleolus"); the two orifices

nearly facing one another. Around the orifice were pale discs not yet arranged into a filament (see par. 18).

Fig. 135. Nuclei of two other cells. One centre is seen in the nucleus α, surrounded by filaments. This centre has its orifice. The nucleus β presents several parts, appearing as though held together by interlacing filaments. Yet perhaps this division of the nucleus into several parts denotes incipient division of the cell into as many minuter cells, of which each part of the divided nucleus would have been the nucleus. See pars. 18, 19.

Fig. 136. Outline of two cells, the nuclei of which had escaped. A filament extended from the situation of an unwinding nucleus to the wall of one of the cells.

Fig. 137. Chick *in ovo*; incubated fifteen days. Outline of cells in the cartilage of one of the phalanges (the terminal one). Filaments indistinctly seen at α. In the nuclei filaments were not seen (as in figs. 133 to 136); yet the discs of which the nuclei were composed (β), appeared like rings: and the central portion of the nucleus γ consisted of two halves as in fig. 134.

Fig. 138. Chick *in ovo*; incubated fifteen days. Filament observed in cartilage of a bone of the leg, more advanced than that in fig. 137.

Fig. 139. Outline of the hair of a Caterpillar, containing filaments, one of which is seen at α (par. 71).

Fig. 140. Sketch of part of two feather-like bodies from the wing of a Gnat. α, α. Structure of the filaments in these objects.

Fig. 141. Sketch of feather-like bodies from the wing of a Butterfly. α. The object entire, and young: β. part of an object of the same kind, more advanced. γ. Structure of the filaments in the object α. δ. Structure of spirals producing transverse (as well as longitudinal) striæ in the object β.

Fig. 142. Spider's web. Fasciculus of filaments. The filament α presents its edge at the middle part. Of the other three filaments, two are on their edge, and the third is on its flat surface. Citric acid. (par. 75).

Fig. 143. Spider's web. Filament on its edge. It crossed some feather-like objects from the wing of a Butterfly; part of one of which is represented in outline in the figure. Citric acid. (par. 75).

PLATE XI.

Figs. 144 to 147½ are not drawn on the same scale as the rest. For the first three of these, the author is indebted to a friend. Fig. 147 is taken from a drawing by Dr. Hesse, in Froriep's Notizen, Juli 1840, No. 309, p. 2. It represents part of Dr. Hesse's fig. 5.

Fig. 144. Frog. Sketch of a large muscular fibril from the heart; α, on its edge (interspaces oblique); β, on its flat surface (par. 92).

Figs. 145, 146. Newt (*Triton cristatus*, Linn.). Sketch of red blood-discs containing filaments; α, on the edge (interspaces oblique); β, on the flat surface (par. 92).

Fig. 147. "Transverse section of the tooth of the Ornithorhynchus near the apex, where the tubes have become closer" (par. 99).

Fig. 147½. From Henle. (Allgemeine Anatomie. Lehre von den Mischungs- und-Formbestandtheilen des menschlichen Körpers, 1841. Taf. IV. fig. 5. I.). From the *nervus ischiadicus* of the Frog; "α ausgetretenes Mark, β zusammengefallene Scheide."

Fig. 148. Man. Sketch of objects from the blood-clot. α. Parent cell; filled with blood-corpuscles having the form of Ammonites. β. More advanced states of such blood-corpuscles, discharged from a parent cell, and seen with others lying in a group. They have the spiral form. γ. Similar blood-corpuscles of a larger size, *i. e.* in a state more advanced: the upper one beginning to undergo division. δ. Spiral fasciculus of filaments (par. 97).

Fig. 149. Newt (*Triton cristatus*, Linn.). Sketch of blood-corpuscles from the forming clot. No addition had been made (par. 96). All are flask-like vesicles (par. 96). α. The membrane without folds. β. Folds are seen. γ. The filament protruding. δ. Two filaments visible in the interior: the nucleus apparently giving them off.

Figs. 150 to 152. Sketches of blood-corpuscles, and of filaments derived from them: as seen in the clot of the Frog and Newt.

Fig. 150. Parent corpuscle, or cell, containing a coiled filament (α), which surrounds two young coiled filaments (β, β). A pellucid nucleus in each of the latter (par. 99).

Fig. 151. Parent corpuscle, or cell, containing a coiled filament, which surrounds many young coiled filaments.

Fig. 152. Coiled filaments, derived from blood-corpuscles: α, with a cavity in the centre; β, unwound.

Fig. 153. Sheep. From the clot of blood: nine hours after the bleeding. Sketch of filaments. α. A spiral having been produced, it is elongating. β. The elongation has proceeded farther; and at γ has produced the appearance of a merely twisted filament. Of these filaments, about half a dozen lay abreast, and some of them were united at their extremities. δ. Structure of the filaments. ε. Similarly twisted filaments. ζ. Spiral; apparently an altered red blood-disc. The whole blood-red.

Fig. 154. Newt (*Lissotriton punctatus*, Bell). From the blood-clot. Sketch of an

enlarged blood-corpuscle, the nucleus of which was undergoing division, for the purpose of producing young corpuscles.

Fig. 155. Sketch of the hair-bulb in a fœtal sheep; which contained nuclei, unwinding into filaments, the filaments interlacing. α. Structure of the filament, as seen on its flat surface. β. Edge of the filament (par. 123).

Fig. 156. Shrimp. α. Sketch of a fasciculus of voluntary muscle, presenting interlaced spirals; some of which are seen pendent at the lower part. β. One of these spirals, the windings of which were distinctly followed.

Fig. 157. Lobster. Sketch of a fasciculus of voluntary muscle: at the lower part *broken off short*; at the middle part *notched* (pars. 118—122). α, β. Displaced extremities of the ruptured spirals. γ. Structure of the spirals.

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*** *This Council will continue till November* 30, 1843.

Omissions having occasionally occurred in the Annual List of Deceased Fellows, as announced from the Chair at the Anniversary Meeting of the Royal Society, any information on that subject, as also Notice of Changes of Residence, will be thankfully received by the Assistant Secretary.

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By a Resolution of the Council (April 11th, 1839,) the President, Treasurer, and Secretaries are, *ex-officio*, Members of all Committees.

THE ROYAL SOCIETY.

30th November, 1842.

THE ROYAL SOCIETY. Nov. 30, 1842.

HER SACRED MAJESTY QUEEN VICTORIA, PATRON.

Date of Election.	
1840. Apr. 30.	HIS ROYAL HIGHNESS, PRINCE ALBERT OF SAXE-COBURG AND GOTHA.
1828. Apr. 24.	HIS ROYAL HIGHNESS, ERNEST AUGUSTUS, DUKE OF CUMBERLAND, KING OF HANOVER.
1828. May 22.	HIS ROYAL HIGHNESS, AUGUSTUS FREDERICK, DUKE OF SUSSEX.
1817. ——	HIS IMPERIAL MAJESTY NICHOLAS, EMPEROR OF ALL THE RUSSIAS.
1842. Jan. 20.	HIS MAJESTY FREDERICK WILLIAM IV., KING OF PRUSSIA.
1816. ——	HIS MAJESTY LEOPOLD, KING OF THE BELGIANS.
1822. June 6.	HIS MAJESTY CHRISTIAN VIII., KING OF DENMARK, D.C.L.
1838. May 24.	HIS IMPERIAL AND ROYAL HIGHNESS, LEOPOLD THE SECOND, GRAND DUKE OF TUSCANY.
1826. Dec. 21.	HIS ROYAL HIGHNESS, JOSEPH FRANCIS OSCAR, CROWN PRINCE OF SWEDEN AND NORWAY.
1816. Feb. 8.	HIS IMPERIAL HIGHNESS, THE ARCHDUKE JOHN OF AUSTRIA.
1816. Feb. 8.	HIS IMPERIAL HIGHNESS, THE ARCHDUKE LOUIS OF AUSTRIA.
1802. Mar. 4.	HIS IMPERIAL HIGHNESS, THE ARCHDUKE MAXIMILIAN OF AUSTRIA.

FELLOWS OF THE SOCIETY.

NOVEMBER 30, 1842.

(*) prefixed to a name indicates that the Member is liable to an annual payment of £2 12s.
(†) prefixed to a name indicates that the Member is liable to an annual payment of £4.

Date of Election.	
1808. Apr. 28.	Aberdeen, George, Earl of, K.T. Trust. Brit. Mus.—President of the Society of Antiquaries. *Argyll-house.*
1839. June 20.	Acland, Sir Thomas Dyke, Bart. M.P., F.G.S. *Killerton-park, Devon.*
1834. Apr. 10.	Adare, Edwin, Viscount. M.P., F.R.A.S. *Adare Abbey, Limerick; Dunraven-castle, Glamorganshire.*
1832. June 7.	† Agar, Hon. George Charles, M.A. *University Club.*
1819. Feb. 18.	Ailsa, Archibald, Marquis of, K.T. *Whitehall-gardens; and Culzean-castle, Ayrshire.*
1836. Jan. 21.	Airy, George Biddell, Esq., M.A., Astronomer Royal. V.P.R.A.S.—Hon. Mem. R.S.E. R.I.A. R.I.S.W. F.C.P.S., Corresp. Mem. National Inst., Washington, U.S. Inst. Reg. Sc. Paris. Corresp., Acad. Imp. Sc. Petrop., Reg. Sc. Berol., Sc. Lit. Panorm., Holm. et Monach. Socc. Reg., Sc. Hafn., Acad. Amer. Art. et Sc. Bost. Socius. *The Royal Observatory, Greenwich.*
1841. June 17.	† Alderson, James, M.D. *Kingston-upon-Hull.*
1835. Nov. 26.	† Alexander, Robert, Esq. F.S.A. 13 *Duke-street, Westminster.*
1807. Nov. 19.	Allen, William, Esq. F.L.S. F.G.S. F.R.A.S. *Plough-court, Lombard-street; and Paradise-row, Stoke Newington.*
1841. Nov. 18.	† Allen, William, Esq., Commander, Royal Navy. 11 *Paragon, Clifton.*
1824. Jan. 22.	Amyot, Thomas, Esq. Treas. S.A. Hon. M.R.I.A. Soc. Reg. Antiq. Septen. Hafn. Socius. 13 *James-street, Westminster.*
1811. May 23.	Anderdon, John Proctor, Esq.
1821. Mar. 29.	Andrew, James, LL.D.
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1841. Feb. 4.	† Atcherley, David Francis, Esq. 52 *Bedford-square; and Marton, near Shrewsbury.*
1840. May. 7.	† Auldjo, John, Esq. *Noel-house, Kensington.*
1830. Mar. 18.	Audubon, John James, Esq.
1837. June 1.	† Ayrton, William, Esq., F.S.A. 4 *James-street, Buckingham-gate.*
1816. Mar. 14.	Babbage, Charles, Esq. M.A. F.R.S.E. Hon. M.R.I.A. F.R.A.S. M.C.P.S. Acadd. Reg. Sc. Masil., Hafn., et Divion. ex intim.: Acad. Amer. Art. et Sc. Bost., Socc. Reg. Œcon. Boruss., et Phys. Hist. Nat. Genev., Socius.—Acadd. Imp. et Reg. Petrop. Pat., Georg. Florent., Brux., Neap., Mut., Lync. Rom., Societ. Philomat. Paris. Corresp. 1 *Dorset-street, Manchester-square.*

Date of Election.

1816. May 23. * Baber, Rev. Henry Hervey, M.A. M.R.S.L. Acad. Reg. Sc. Monach. Socius. *Stretham, Cambridgeshire.*

1828. Mar. 13. Babington, Benjamin Guy, M.D. 31 *George-street, Hanover-square.*

1836. Feb. 11. † Baillie, David, Esq. 14 *Belgrave-square.*

1842. Jan. 13. † Baily, Edward Hodges, Esq. R.A. 10 *Percy-street, Tottenham-court-road.*

1821. Feb. 22. Baily, Francis, Esq.—VICE-PRESIDENT.—D.C.L. Hon. M.R.I.A. F.L.S. F.G.S.—V.P.R.A.S.—Instit. Reg. Sc. Paris. Corresp.—Acadd. Reg. Sc. Berolin, Neap., et Sc. et Lit. Panorm. Corresp.—Acad. Amer. Art. et Sc. Bost. Socius. 37 *Tavistock-place, Russell-square; and East Tytherley, in Hampshire.*

1828. Dec. 11. † Baird, Andrew, M.D. 2 *Clarges-street, Piccadilly.*

1841. June 10. † Baring, Sir Thomas, Bart. 21 *Devonshire-place; and Stratton-park, Winchester.*

1839. June 6. † Barker, George, Esq. *Birmingham.*

1834. Dec. 18. Barlow, Rev. John, M.A. F.L.S. Sec. R.I. 22 *Henrietta-street, Cavendish-square.*

1823. May 29. Barlow, Peter, Esq. F.R.A.S. Hon. F.C.P.S. Acadd. Imp. Sc. Petrop. Amer. Art. et Sc. Bost. Socius.—Instit. Reg. Sc. Paris., et Acad. Reg. Sc. Brux. Corresp. *Royal Military Academy, Woolwich.*

1819. Jan. 21. Barlow, Rear-Admiral Sir Robert, K.C.B. *Canterbury.*

1818. Nov. 12. Barnewell, Rev. Frederick Henry, M.A. F.S.A. *Bury St. Edmunds.*

1809. Mar. 9. Barnwell, Charles Frederick, Esq. M.A. F.S.A. 44 *Woburn-place, Russell-square.*

1823. Feb. 13. Baron, John, M.D. *Cheltenham.*

1805. July 4. Barrow, Sir John, Bart. F.L.S. 21 *New-street, Spring-gardens.*

1840. Feb. 13. † Barry, Martin, M.D. F.R.S.E. M.W.S. Fellow of the Royal College of Physicians in Edinburgh. 40 *Trinity-square, Tower-hill; and Edinburgh.*

1838. Feb. 8. † Bateman, James, Esq. F.L.S. F.R.G.S. F.S.H. *Knypersley-hall, Staffordshire.*

1814. Feb. 14. * Bath and Wells, George Henry Law, Lord Bishop of. F.S.A. *Wells, Somersetshire.*

1822. Feb. 28. Batty, Lieut.-Colonel Robert. 6 *Euston-place, New-road.*

1828. Feb. 21. † Baylay, Rev. William Frederick, M.A. F.S.A. *Canterbury.*

1827. Nov. 15. Beamish, Major North Ludlow, K.H. *Windham Club, St. James's-square.*

1836. Mar. 24. Beamish, Richard, Esq. *Sans Souci, Prestbury, Cheltenham.*

1809. Dec. 7. Beauclerk, Vice-Admiral Lord, Amelius, K.C.B. G.C.H. *Plymouth.*

1814. June 30. Beaufort, Francis, Esq. Captain in the Royal Navy, F.G.S. F.R.A.S. Instit. Sc. Paris. Corresp. *Admiralty; and* 11 *Gloucester-place, Portman square.*

1815. Dec. 14. Beaufoy, Henry, Esq. F.L.S. *South Lambeth.*

1835. June 4. † Beaumont, Edward Blackett, Esq. F.R.A.S. *Finningly-park, near Bawtry, Yorkshire.*

1816. Mar. 14. Beckett, Right Hon. Sir John, Bart. LL.D. 11 *Stratford-place; and Somerby-park, Gainsborough.*

1824. Dec. 23. † Beechey, Frederick William, Esq. Captain in the Royal Navy, F.R.A.S. *Worthing.*

1835. Feb. 5. † Beetham, Albert William, Esq. F.S.A. F.L.S. 5 *King's-bench-walk, Temple; and Forest-lodge, Tulse-hill, Surrey.*

1828. Jan. 10. Bell, Thomas, Esq. F.L.S. F.G.S. Socc. Hist. Nat. et Philomath. Paris, Acad. Sc. Philad. et Soc. Hist. Nat. Bost. Corresp. Prof. of Zoology, King's College, London. 17 *New Broad-street; and Hornsey, Middlesex.*

1834. Dec. 18. † Bellamy, Rev. James William, B.D. *Merchant Tailors' School, Suffolk-lane.*

1841. Dec. 16. † Bennett, John Joseph, Esq. Sec. L.S. *British Museum.*

1831. May 5. Beverly, Charles James, Esq. 1 *Hackney-grove, Hackney.*

Date of Election.	
1822. Feb 7.	Bexley, Nicholas Lord, M.A. F.S.A. M.R.S.L. 31 *Great George-street; and Foot's-Cray-place, Kent.*
1827. May 10.	Bicheno, James Ebenezer, Esq. F.L.S. F.G.S. *Ty-Maen, near Pyle, Glamorganshire.*
1821. Mar. 8.	Bicknell, John Laurens, Esq. 25 *Abingdon-street.*
1837. June 8.	† Bigsby, Robert Grymbald, Esq. F.S.A. *Repton, near Burton-on-Trent, Staffordshire.*
1809. June 22.	Bingley, Robert, Esq. F.G.S. *Royal Mint, Tower-hill; and Woodford Essex.*
1841. Jan. 21.	† Blackiston, Peyton, Esq. *Birmingham.*
1830. Mar. 4.	Blake, Captain Benjamin, F.G.S. F.R.A.S. *India.*
1807. May 14.	Blake, William, Esq. M.A. F.G.S. 62 *Portland-place; and Dancsbury, near Welwyn, Hertfordshire.*
1831. Jan. 20.	Blake, William John, Esq. 62 *Portland-place.*
1816. Feb. 8.	Bland, Michael, Esq. F.S.A. F.L.S. F.G.S. *St. Leonard's, Hastings.*
1821. Apr. 12.	Bland, Rev. Miles, D.D. F.S.A. F.R.A.S. M.R.S.L. *Lilley Rectory, near Luton.*
1841. June 10.	† Blore, Edward, Esq. 4 *Manchester-square.*
1837. May 11.	Boase, Henry, M.D. F.G.S. *Claverhouse, near Dundee.*
1840. Mar. 5.	† Boileau, John Theophilus, Esq., Capt. E.I.C.S. *India.*
1840. June 18.	† Bonner, Lieut.-Col. John George, E.I.C.S. 11 *A, Great Cumberland-street, Hyde-park.*
1834. Apr. 10.	† Booth, Sir Felix, Bart. 43 *Portland-place; and Hendon, Middlesex.*
1835. June 4.	† Borrer, William, Esq. F.L.S. *Henfield, Sussex.*
1793. June 6.	Bosanquet, Samuel, Esq. 73 *Lombard-street.*
1818. Apr. 2.	Bostock, John, M.D. F.L.S. F.G.S. F.R.A.S. 22 *Upper Bedford-place.*
1829. June 4.	Bosworth, Rev. Joseph, LL.D. F.S.A. M.R.S.L. Soc. Reg. Antiq. Septen. Hafn. Corresp. Socc. Reg. Sc. Norv., Dronth., et Gothenb., Socius. *Carrington, Nottingham.*
1839. Jan. 17.	Botfield, Beriah, Esq., M.P. F.S.A. F.R.A.S. F.G.S. F.L.S. *Norton-hall, Northamptonshire.*
1833. Apr. 18.	† Botfield, Thomas, Esq. F.G.S. *Hopton-court, Bewdley.*
1814. May 5.	Boughton, Sir William Edward Rouse, Bart. *Downton-hall, Ludlow.*
1826. Apr. 20.	Bourne, Right Hon. William Sturges, M.A. 32 *Upper Brook-street; and Testwood-house, Southampton.*
1842. Nov. 17.	Bowerbank, James Scott, Esq. F.G.S. 45 *Park-street, Islington.*
1841. Apr. 22.	Bowman, William, Esq. 3 *Norfolk-street, Strand.*
1814. June 23.	Boyle, Hon. Sir Courtenay, Knt. 24 *Upper Berkeley-street; and Hampton-court Palace.*
1809. Apr. 13.	Brande, William Thomas, Esq., Professor of Chemistry in the Royal Institution. F.R.S.E. *Royal Mint, Tower-hill.*
1821. Mar. 8.	Brandreth, Thomas Shaw, Esq. *University-club.*
1841. Jan. 21.	† Brandreth, Henry Rowland, Esq., Captain in the Royal Engineers. *Somerset-house.*
1834. June 5.	† Breadalbane, John Campbell, Marquis of. 21 *Park-lane; and Taymouth-castle, Aberfeldie.*
1815. May 4.	Brewster, Sir David, K.H. LL.D., F.R.S.E. Hon. M.R.I.A. F.G.S. F.R.A.S. Instit. Reg. Sc. Paris. Corresp.—Soc. Reg. Sc. Gotting. Socius. *St. Andrew's, St. Leonard's, N.B.*
1821. Mar. 15.	Bridgman, William, Esq. F.S.A. *Frogmore, Gloucester.*
1838. Nov. 22.	† Briggs, Major-General John, E.I.C.S. M.R.A.S. F.G.S. 2 *St. James's-square, Cheltenham.*
1821. Mar. 8.	Bright, Richard, M.D. F.G.S. Soc. Reg. Sc. Hafn. Socius.—Acad. Sc. Sien., Socc. Erud. Hung., et Medico-Chir. Berolin., Corresp. 11 *Saville-street.*
1810. May 10.	Brisbane, Lieut.-General Sir Thomas Macdougall, K.C.B. G.C.H. D.C.L. F.R.S.E.

Date of Election.	
	Hon. M.R.I.A. F.R.A.S. Instit. Reg. Sc. Paris. Corresp.—President of the Royal Society of Edinburgh. *Makerstown, Kelso.*
1805. May 23.	Bristol, Frederick William, Marquis of. 6 *St. James's-square; and Ickworth-park, Bury St. Edmunds.*
1834. Dec. 18.	† Brockedon, William, Esq. 29 *Devonshire-street, Queen's-square.*
1828. Feb. 14.	Broderip, William John, Esq. B.A. F.L.S. V.P.G.S. 2 *Raymond's-buildings, Gray's-inn.*
1810. Feb. 15.	* Brodie, Sir Benjamin Collins, Bart. Serjeant Surgeon to the Queen. 14 *Saville-street.*
1817. Mar. 13.	Bromhead, Sir Edward Ffrench, Bart. M.A. F.R.S.E. F.R.A.S. *Thurlby, Lincolnshire.*
1823. May 29.	Brooke, Sir Arthur Brooke de Capell, Bart. M.A. F.L.S. F.G.S. *Okeley, Northamptonshire.*
1819. Apr. 22.	Brooke, Henry James, Esq. F.L.S. F.G.S. *Clapham-Rise.*
1803. Mar. 3.	Brougham, and Vaux, Henry, Lord, M.A. Instit. Reg. Sc. Paris. Socius. 4 *Grafton-street; and Brougham-hall, Penrith.*
1842. Feb. 17.	† Broughton, Robert Edwards, Esq. 1 *Melcombe-place.*
1811. Dec. 12.	Brown, Robert, Esq., D.C.L. Hon. Mem. R.S.E., R.I.A. and C.P.S. V.P.L.S. Instit. Reg. (Acad. Scient.) Paris. Socius.—Acadd. Imp. Sc. Petrop., et Cæs. Nat. Cur., Reg. Sc. Berol., Holm. et Monach., Socc. Reg. Sc. Hafn. et Upsal., Instit. Reg. Sc. Amstelod., Socc. Sc. Harlem., Trajectin., Phys. et Hist. Nat. Genev., Imp. Hist. Nat. Mosc., Nat. Scrutat. Berolin., Wetter, Phil. Nov-Ebor., et Med. Holm. Socius. Acadd. Reg. Sc. Bruxell., et Bonon. Corresp. 17 *Dean-street, Soho-square.*
1838. May 8.	Brownlow, John, Earl. D.C.L. F.S.A. F.L.S. F.G.S. M.R.A.S. 12 *Belgrave-square; and Belton-house, Grantham.*
1829. Mar. 18.	Bruce, Right Hon. Sir James Lewis Knight, Knt., F.S.A. *Roehampton Priory.*
1830. June 10.	Brunel, Isambard Kingdom, Esq. 18 *Duke-street, Westminster.*
1814. Mar. 24.	Brunel, Sir Mark Isambard, Knt. Instit. Reg. Sc. Paris., et Acad. Reg. Sc. Monach., Corresp. *Thames Tunnel.*
1833. June 20.	Buccleuch, Walter Francis, Duke of, K.T. D.C.L. *Whitehall-gardens; and Dalkeith-house, Edinburgh.*
1818. Feb. 26.	Buckland, Rev. William, D.D., Professor of Mineralogy and Geology, Oxford. President of the Geological Society. F.L.S. Instit. Reg. Sc. Paris. Corresp., Socc. Min. Imp. Petrop. et Cæs. Nat. Cur. Mosc., Socius. *Christ-church, Oxford.*
1836. Jan. 21.	† Budd, George, M.D. 20 *Dover-street, Piccadilly; and Caius-college, Cambridge.*
1840. May 21.	† Burge, William, Esq. 1 *Paper-buildings, Temple.*
1829. Dec. 10.	Burlington, William, Earl of, M.A. Chancellor of the University of London.—F.G.S. 10 *Belgrave-square; and Hardwick-hall, Derbyshire.*
1835. Apr. 2.	Burnes, James, K.H. D.C.L. *India.*
1837. Mar. 16.	† Burnet, John, Esq. 2 *Whiteheads Grove, Chelsea.*
1838. May 3.	† Burnet, Rev. Thomas, D.D, Rector of St. James, Garlickhythe.
1833. Apr. 18.	† Burnett, Sir William, K.C.H. M.D. Coll. Reg. Med. Socius.—Acadd. Med. et Chir. Petrop. Socius Honor. 5 *Somerset-place.*
1814. Dec. 22.	Burney, Rev. Charles Parr, D.D. F.S.A. F.L.S. F.G.S. F.R.A.S. M.R.A.S. M.R.S.L. *Rectory-house, Sible Hedingham, near Halsted, Essex.*
1829. Apr. 1.	Burns, John, M.D. *Glasgow.*
1818. Feb. 26.	Burrow, Rev. Edward John, D.D. F.L.S. F.G.S. *Gibraltar.*
1836. Mar. 17.	Burt, Major T. Seymour, M.R.A.S. 32 *Essex-street, Strand; and India.*
1832. Dec. 6.	Burton, Decimus, Esq. F.S.A. 6 *Spring-gardens; and St. Leonard's, Hastings.*

Date of Election.	
1836. May 5.	† Burton, Edward, Esq. F.L.S. *Chatham.*
1818. Jan. 8.	Bute, John, Marquis of, D.C.L. F.S.A. F.R.A.S. *Camden-hill, Kensington; and Cardiff-castle, Glamorganshire.*
1819. May 20.	Butler, Rev. George, D.D. F.S.A. F.R.A.S.
1822. Mar. 21.	Butter, John, M.D. F.L.S. *Plymouth; and Corringdon-hall, South Brent, Devonshire.*
1841. May 6.	† Byng, Right Hon. George Stevens, M.P. 77 *Eaton-square.*
1837. Jan. 19.	Cabbell, Benjamin Bond, Esq. F.S.A. 1 *Brick-court, Temple.*
1810. June 28.	Cadell, William Archibald, Esq. F.R.S.E. F.G.S. *Edinburgh.*
1831. Mar. 10.	Caldcleugh, Alexander, Esq. F.L.S. F.G.S. *Chili.*
1840. Feb. 20.	Caldecott, John, Esq. F.R.A.S. *Observatory, Travancore, India.*
1796. Nov. 17.	Canterbury, Right Hon. William Howley, D.D., Lord Archibishop of. Trust. Brit. Mus. F.S.A. M.R.S.L. *Lambeth-palace.*
1820. Mar. 2.	Card, Rev. Henry, D.D. F.S.A. *Great Malvern, Worcestershire.*
1839. Feb. 14.	† Carington, Robert John, Lord. *Whitehall-yard; and Wycombe-abbey, Wendover-house, Bucks.*
1826. Feb. 9.	Carleton, Hon. and Rev. Richard, M.A. *Greywell-hill, Odiham, Hampshire.*
1814. May 19.	Carlisle, Nicholas, Esq. K.H. D.C.L. Hon. M.R.I.A. Sec. A.S. Soc. Reg. Antiq. Septen. Hafn., et Acad. Reg. Sc. Holm. Socius. Acad. Sc. et Lit. Panorm. Corresp. *Somerset-house.*
1838. May 3.	† Carnac, Sir James Rivett, Bart.
1818. May 28.	Carne, Joseph, Esq. M.R.I.A. F.G.S. *Penzance.*
1817. Feb. 13.	* Carpue, Joseph Constantine, Esq. 45 *Upper Charlotte-street, Fitzroy-square.*
1800. Dec. 18.	Carrington, Sir Codrington Edmund, Knt. D.C.L. F.S.A. M.R.A.S. 32 *Russell-square.*
1837. June 1.	† Carson, James, M.D. *Liverpool.*
1841. Feb. 11.	Cartwright, Samuel, Esq. 32 *Old Burlington-street.*
1812. June 11.	Cawdor, John Frederick, Earl, Trust. Brit. Mus. F.G.S. 74 *South Audley-street; and Cawdor-castle, Nairn.*
1828. Mar. 13.	Chambers, William Frederick, M.D. K.C.H. Physician to the Queen. Coll. Reg. Med. Socius. 46 *Brook-street.*
1833. Feb. 7.	† Chandler, George, Dean of Chichester, D.C.L. M.R.S.L. R.G.S. 36 *Mortimer-street.*
1816. Nov. 21.	Chapman, Colonel Sir Stephen Remnant, C.B. K.C.H. Royal Engineers. *Bermudas.*
1836. Apr. 28.	† Chapman, John James, Esq., Captain Royal Artillery. *Athenæum.*
1842. May 26.	Chapman, Thomas, Esq. F.S.A. 14 *Montague-place; and Whitby, Yorkshire.*
1834. Feb. 6.	Chesney, Lieut.-Colonel F. R., Royal Artillery. 11 *Wilton-terrace, Grosvenor-place.*
1807. Mar. 12.	Children, John George, Esq. F.R.S.E. F.S.A. F.L.S. 48 *Torrington-square.*
1826. Jan. 12.	Christie, Samuel Hunter, Esq. M.A.—SECRETARY.—F.R.A.S. Professor of Mathematics, Royal Military Academy. Acad. Sc. et Lit. Panorm., et Soc. Philom. Paris. Corresp. *Royal Military Academy, Woolwich.*
1842. Apr. 14.	† Christmas, Rev. Henry, M.A. F.S.A. *Sion-college, London Wall.*
1833. Apr. 18.	Christopher, Robert Adam Dundas, Esq. 97 *Eaton-square.*
1818. Dec. 10.	Churchill, Francis Almaric, Lord. *Cornbury-park, near Witney, Oxfordshire.*
1832. June 7.	Clark, Sir James, Bart., M.D. Physician to the Queen. 22 *B, Brook-street.*
1836. Jan. 28.	† Clark, William, M.D. *Cambridge.*
1837. May 11.	† Clark, William Tierney, Esq. *Hammersmith.*
1825. June 9.	Clarke, Sir Charles Mansfield, Bart. M.D. 54 *Wimpole-street; and Dunham-lodge, Swaffham, Norfolk.*

Date of Election.	
1820. May 18.	Clarke, Loftus Longueville, Esq. M.A. *India.*
1821. June 7.	Clarke, William Stanley, Esq. F.G.S. *East-India-house; and Leatherhead, Surrey.*
1819. May 27.	Clerk, Sir George, Bart. D.C.L. M.P. F.R.S.E. F.G.S. 8 *Park-street, Westminster.*
1833. Apr. 18.	† Clerke, Major T. H. Shadwell, K.H. F.R.A.S. 4 *Brompton-grove.*
1841. Feb. 18.	† Clendinning, John, M.D. 16 *Wimpole-street.*
1823. May 8.	Clift, William, Esq. F.G.S. *Royal College of Surgeons, Lincoln's-inn-fields.*
1828. June 5.	† Clifton, Marshall Waller, Esq. *Boulogne.*
1820. Dec. 21.	Cockburn, Vice-Admiral Right Hon. Sir George, G.C.B. G.C.H. F.R.A.S.
1829. Feb. 12.	Coddington, Rev. Henry, M.A. F.R.A.S. *Ware, Hertfordshire.*
1822. Nov. 21.	Codrington, Vice-Admiral Sir Edward, G.C.B. *Admiralty-house, Portsmouth; and Hampton-lodge, Brighton.*
1820. Apr. 13.	Colby, Colonel Thomas, Royal Engineers, LL.D. F.R.S.E. Hon. M.R.I.A. F.G.S. F.R.A.S. M.R.A.S. *Ordnance Map Office, Tower; and Depôt Ordnance Survey of Ireland, Dublin.*
1830. Feb. 18.	Collier, Charles, M.D. F.G.S. 20 *Fitzroy-square.*
1830. Jan. 14.	† Colquhoun, Major James Nisbet, Royal Artillery. *Athenæum-club.*
1839. Feb. 21.	† Conolly, Arthur, Esq. Captain in the Bengal Cavalry Service. *Bengal.*
1819. Dec. 9.	Conybeare, Rev. William Daniel, M.A. F.G.S. Instit. Reg. Sc. Paris. Corresp. *Axminster.*
1840. June 4.	† Cook, Thomas, Esq. Lieut. Royal Navy. *Croydon, Surrey.*
1829. June 18.	Cooper, Bransby Blake, Esq. 2 *New-street, Spring-gardens.*
1832. Dec. 6.	Cooper, Charles Purton, Esq. LL.D. Hon. M.R.I.A. 7 *New Boswell-court, Lincoln's-inn.*
1834. Feb. 6.	Copeland, Thomas, Esq. *Cavendish-square.*
1833. Dec. 5.	† Copland, James, M.D. Coll. Reg. Med. Socius. 5 *Burlington-street.*
1821. May 24.	Cotton, William, Esq. F.S.A. 3 *Crosby-square, Bishopsgate-street; and Walwood-house, Leytonstone.*
1836. May 5.	† Cox, William Sands, Esq. *Birmingham.*
1812. Apr. 16.	Crampton, Sir Philip Cecil, Bart. D.C.L. *Dublin.*
1818. May 7.	Crawford, John, Esq. F.L.S. F.G.S. M.R.A.S.
1823. Nov. 20.	Cresswell, Rev. Daniel, D.D. *Enfield, Middlesex.*
1800. May 8.	* Crichton, Sir Alexander, Knt. M.D. Grand Cross of St. Anne and St. Vladimir. F.L.S. F.G.S. Acad. Imp. Sc. Petrop., et Soc. Hist. Nat. Mosc., Socius.—Soc. Reg. Sc. Gotting. Corresp. *Seal Chart, near Sevenoaks, Kent.*
1818. Mar. 5.	Croft, Sir John, Bart. K.T.S. D.C.L. Acad. Reg. Olyssip. Socius. *Milgate, near Maidstone.*
1810. July 5.	Croker, Right Hon. John Wilson, LL.D. 6 *Park-street, Westminster.*
1836. Feb. 18.	† Crosse, John Green, M.D. Acad. Reg. Med. Paris., Soc. Reg. Med. Hafn. Med. Chir. Berolin., Soc. Amer. Phis. Philad. Socius. *Norwich.*
1830. Apr. 1.	Cubitt, William, Esq. M.R.I.A. F.R.A.S. 6 *Great George-street, Westminster.*
1807. Jan. 22.	Cuming, Lieut.-General Hon. John Leslie.
1816. Jan. 11.	Cumming, Rev. James, M.A., Professor of Chemistry, Cambridge, F.G.S. *Cambridge.*
1838. Jan. 25.	† Cureton, Rev. William, M.A. F.S.A. 31 *A, Bedford-square; and British Museum.*
1841. May 27.	Cursetjee, Ardaseer, Esq. *Bombay.*
1834. Feb. 6.	† Cust, Hon. Sir Edward, K.C.H. 30 *Hill-street.*
1822. Mar. 7.	Dalton, John, Esq. D.C.L. Hon. M.R.I.A. Instit. Reg. Sc. Paris., et Acad. Reg. Sc. Monach., Socius. *Philosophical Society, Manchester.*

Date of Election.		
1828. June 5.	†	Daniell, Edmund Robert, Esq. *Birmingham.*
1814. May 5.	*	Daniell, John Frederic, Esq.—FOREIGN SECRETARY.—Professor of Chemistry, King's-college, London, Soc. Phil. Batav., Sc. Phil. Basle, Socius Honor. *Norwood.*
1822. Nov. 7.		Dartmouth, William, Earl of, D.C.L. F.S.A. 1 *St. James's-square; and Sandwell-park, Birmingham.*
1834. Jan. 29.		Darwin, Charles, Esq. M.A. Sec. G.S. *Down, near Bromley, Kent.*
1788. Feb. 21.		Darwin, Robert Waring, M.D. *Shrewsbury.*
1822. Dec. 19.		Daubeny, Charles Giles Bridle, M.D., Aldrich's Professor of Chemistry, Regius Professor of Botany, Oxford. Hon. M.R.I.A. F.L.S. F.G.S. Coll. Reg. Med. Socius. *Oxford.*
1839. May 30.	†	Davenport, Edward Davies, Esq. *Capesthorne, Cheshire.*
1831. June 16.		Davies, Griffith, Esq. *Palmer-terrace, Islington.*
1833. Apr. 18.		Davies, Thomas Stephens, Esq. F.R.S.E. F.S.A. *Royal Military Academy, Woolwich.*
1841. May 20.	†	Davis, Hart, Esq. *Hampstead-heath.*
1822. Mar. 28.		Davis, John Francis, Esq. *Portland-place; and Hollywood, near Compton, Bristol.*
1826. Jan. 19.		Davy, Edmund, Esq., Prof. of Chemistry to the Royal Dublin Society, M.R.I.A. *Dublin.*
1814. Feb. 17.		Davy, John, M.D. F.R.S.E. *Murray-field-house, near Edinburgh.*
1815. Mar. 9.		Dawkins, James Colyer, Esq. F.S.A. *Ham-common, Richmond.*
1811. Feb. 28.		Dealtry, Rev. William, D.D. F.R.A.S. *Clapham-common.*
1819. Dec. 23.		De la Beche, Sir Henry T., Knt. F.L.S. F.G.S., Director of the Ordnance Geological Survey of Great Britain. *Museum of Economic Geology, 6 Craig's-court, Charing Cross.*
1839. Feb. 28.	†	Denham, Henry Mangles, Esq. Commander in the Royal Navy. *Liverpool.*
1841. May 20.	†	Denham, Rev. Joshua Frederick, M.A. 1 *New Inn.*
1838. Feb. 22.		Denison, William Thomas, Esq. Lieut. in the Royal Engineers. F.R.A.S. F.R.G.S. *Wood-street, Woolwich.*
1833. June 20.	†	Denman, Thomas, Lord. 38 *Portland-place; and Stoney Middleton, Derbyshire.*
1804. Feb. 2.		Dillwyn, Lewis, Weston, Esq. F.L.S. F.G.S. *Sketty-hall, near Swansea.*
1832. June 7.	†	Disney, John, Esq. F.S.A. *The Hyde, near Ingatestone, Essex.*
1811. Mar. 21.		Dixon, Rev. Richard, M.A. *Niton, Isle of Wight.*
1835. June 4.	†	Dobson, Sir Richard, Knt. *Royal Hospital, Greenwich.*
1819. Dec. 23.		Dollond, George, Esq. F.R.A.S. 59 *St. Paul's Churchyard; and North-terrace, Camberwell.*
1838. Jan. 18.	†	Donkin, Bryan, Esq. F.R.A.S. 6 *Paragon, Kent-road.*
1842. Jan. 13.	†	Donkin, William Fishburn, Esq. M.A., Savilian Professor of Astronomy in the University of Oxford.
1830. Jan. 28.		Douglas, George, Esq. *Chilston, Kent.*
1816. Jan. 25.	*	Douglas, Major-General Sir Howard, Bart. C.B. K.S.C. D.C.L. F.S.A. 15 *Green-street, Grosvenor-square.*
1826. Mar. 9.		Douglas, William Robert Keith, Esq.
1815. Mar. 16.		D'Oyly, Rev. George, D.D. *Rectory, Lambeth.*
1839. Feb. 28.	†	Drew, Richard, Esq. *Trinity-house.*
1836. Feb. 4.	†	Drory, George William, Esq. *Ghent.*
1818. Feb. 26.		Drury, Rev. Henry, M.A. F.S.A. *Harrow.*
1839. Dec. 19.	†	Drummond, Henry, Esq. *Albury-park, Guildford, Surrey.*

Date of Election.		
1808. Dec. 8.		Duckett, Sir George, Bart. M.A. F.S.A. F.G.S. Hon. M.R.I.S. *Roydon, near Ware, Hertfordshire.*
1825. Mar. 10.		D'Urban, Major-General Sir Benjamin, K.C.B. K.C.H. K.T.S.
1824. Feb. 19.		Durham, Edward Maltby, D.D. Lord Bishop of. F.S.A. 28 *Curzon-street; and Auckland-castle, Durham.*
1799. Apr. 11.		East, Right Hon. Sir Edward Hyde, Bart. M.R.A.S. *Paladium-office, Waterloo-place; and Sherwood Lodge, Battersea.*
1838. Jan. 25.	†	Eastlake, Charles Lock, Esq. R.A. 13 *Upper Fitzroy-street.*
1822. Nov. 14.		Edgeworth, Lovell, Esq. *Edgeworth's-town, Ireland.*
1829. Feb. 26.		Edwards, W. F., M.D. *Rue Louis-le-Grand, No. 26, Paris.*
1835. Feb. 5.	†	Edye, John, Esq. 9 *Mecklenburgh-square.*
1841. Jan. 21.	†	Edye, Joseph, Esq. *Portsmouth.*
1831. Feb. 10.		Egerton, Sir Philip de Malpas Grey, Bart. M.P. F.G.S. 30 *Eaton-place*; *and Oulton-park, Cheshire.*
1815. Mar. 2.		Elliot, Sir William Francis, Bart. *Stobb's Castle; and* [redacted]*ls, N.B.*
1834. June 5.		Elliot, Hon. George, Captain in the Royal Navy.
1829. Mar. 19.		Elliotson, John, M.D. Coll. Reg. Med. Socius. 37 *Conduit-street.*
1835. Nov. 26.	†	Elliott, Charles, Esq. 47 *Portland-place.*
1832. Apr. 5.		Elliott, Rev. Charles Boileau, M.A. 47 *Portland-place; and Tattingstone, Suffolk.*
1811. May 30.	*	Ellis, Sir Henry, K.H. B.C.L. Sec. S.A. Hon. M.R.I.A. Hist. Scand. Holm. et Soc. Reg. Antiq. Hafn. Socius.—Soc. Reg. Antiq. Franc. Corresp. Principal Librarian of the British Museum. *British Museum.*
1819. Feb. 11.		Ellis, Right Hon. Henry, F.G.S.
1801. Mar. 12.		Ellis, John, Esq. F.L.S.
1832. June 7.	†	Elphinstone, Howard, Esq M.A. F.G.S. 19 *Eaton-place, Belgrave-square.*
1841. Jan. 14.		Enderby, Charles, Esq. *Greenwich.*
1829. Jan. 15.		Enniskillen, William Willoughby, Earl of, D.C.L. F.G.S. 111 *A, Jermyn-street; and Florence-court, Fermanagh, Ireland.*
1827. Mar. 8.		Everest, Lieut.-Colonel George, Bengal Artillery, F.G.S. F.R.A.S. M.R.A.S. *Surveyor-General of India.*
1840. May 21.	†	Ewer, Walter, Esq. 23 *Hanover-square.*
1824. Jan. 8.		Faraday, Michael, Esq. D.C.L., Fullerian Professor of Chemistry in the Royal Institution of Great Britain. Hon. Mem. R.S.E., C.P.S. F.G.S. Acad. Imp. Sc. Petrop. Socius Honor.—Acad. Reg. Sc. Holm., Soc. Reg. Sc. Hafn., Acad. Reg. Sc. Mut. Acad. Amer. Art. et Sc. Bost. Socius, Instit. Reg. Sc. Paris, et Acad. Reg. Sc. Berol., Socius et Corresp. Soc. Georg. Florent., Soc. Philom. Paris, Acad. Reg. Med. Paris. Corresp. 21 *Albemarle-street.*
1830. Jan. 28.	†	Farquharson, Rev. James, M.A. LL.D. *Alford, Aberdeenshire.*
1839. May 2.	†	Farre, Arthur, M.D. 22 *Curzon-street, May-fair.*
1835. April 2.	†	Featherstonhaugh, G.W., Esq., Her Majesty's Commissioner for the North American Boundary. *Foreign Office, Downing-street.*
1816. Feb. 29.		Fellowes, Sir James, Knt. M.D. Coll. Reg. Med. Socius. 62 *Chester-square.*
1836. Mar. 3.		Field, Joshua, Esq. *Cheltenham-place, Lambeth.*
1842. May 5.	†	Fielding, George Hunsley, M.D. *Albion-street, Kingston-upon-Hull.*
1825. Jan. 27.		Fisher, Rev. George, M.A. F.R.A.S. *Royal Hospital, Greenwich.*

Date of Election.	
1815. Nov. 9.	Fitton, William Henry, M.D. F.L.S. F.G.S. F.R.A.S. Coll. Reg. Med. Socius. 53 *Upper Harley-street.*
1816. May 2.	Fitzgerald and Vesey, William, Vesey Lord, Trust. Brit. Mus. M.R.I.A. 17 *Whitehall-place.*
1811. Jan. 17.	Fitzwilliam, Charles William, Earl, F.S.A. F.G.S. *Mortimer-house, Grosvenor-place; and Wentworth-house, near Rotherham, Yorkshire.*
1806. Feb. 27.	FitzWygram, Sir Robert, Bart. D.C.L. Hon. M.R.I.A. F.S.A. 10 *Connaught-place.*
1839. Mar. 21.	Fletcher, Thomas William, Esq. F.S.A. *Dudley, Worcestershire.*
1834. Apr. 10.	† Folkes, Sir William Browne, Bart. *Hillington-hall, Lynn.*
1832. June 7.	Forbes, James David, Esq. Professor of Natural Philosophy in the University of Edinburgh. Sec. R.S.E. F.G.S. *Edinburgh.*
1829. Feb. 5.	Forbes, John, M.D. 12 *Old Burlington-street.*
1822. Feb. 21.	Forbes, William Nairn, Esq. F.G.S.
1828. June. 12.	† Forshall, Rev. Josiah, M.A. F.S.A. Hon. M.R.I.A. M.R.S.L. *British Museum.*
1821. Feb. 22.	Forster, Edward, Esq. V.P.L.S. 11 *Mansion-house-street; and Woodford, Essex.*
1817. June 5.	Fortescue, Hugh, Earl. 17 *Grosvenor-square; and Castle-hill, Southmolton.*
1802. April 1.	Fowler, Richard, M.D. F.S.A. *Salisbury.*
1821. July 12.	Franck, James, M.D. F.G.S. Coll. Reg. Med. Socius. 26 *Hertford-street.*
1823. Feb. 20.	Franklin, Sir John, Knt. Captain in the Royal Navy, D.C.L. F.L.S. F.G.S. F.R.A.S. Soc. Geogr. Paris. Corresp. *Governor of Van Diemen's Land.*
1821. Dec. 12.	Franks, William, Esq. M.A. *Wood-hill, Hatfield, Hertfordshire.*
1837. June 8.	Frere, George Edward, Esq. *Twerton, near Bath.*
1834. Apr. 10.	† Freshfield, James William, Esq. F.G.S. 15 *Regent-street; and Leatherhead, Surrey.*
1820. Mar. 16.	Friend, Matthew Curling, Esq. Lieut. Royal Navy. *George Town, Van Diemen's Land.*
1839. Jan. 10.	† Frodsham, William James, Esq. *Change-alley, Cornhill.*
1834. Dec. 18.	† Galloway, Thomas, Esq. M.A. F.R.A.S. 13 *Sergeant's-inn, Fleet-street.*
1816. April 4.	Gardiner, Rev. Samuel John, M.A.
1840. April 9.	† Gassiot, John P., Esq. *Clapham-common.*
1839. Mar. 21.	Gaskin, Rev. Thomas, M.A. F.R.A.S. *Jesus-college, Cambridge.*
1796. Feb. 18.	Gibbes, Sir George Smith, Knt. M.D. F.L.S. Coll. Reg. Med. Socius. *Bath.*
1834. Apr. 10.	Gilbert, John Davies, Esq. M.A. *Eastbourne, Sussex; and Tredrea, Cornwall.*
1788. June 5.	Glasgow, George, Earl of, G.C.H. F.S.A. *Boroughbridge, Yorkshire.*
1828. Mar. 27.	Glenelg, Charles, Lord, D.C.L. M.R.S.L. *Board of Trade, Whitehall; and Glenelg, Inverness.*
1832. June 7.	† Glover, Rev. George, M.A., Archdeacon of Sudbury. *Southreppo, Norfolk.*
1838. Feb. 8.	Glynn, Joseph, Esq. *Butterley, Derbyshire.*
1839. Mar. 7.	† Godwin, George, jun., Esq. F.S.A. 11 *Pelham-crescent, Brompton.*
1808. May 26.	Goldingham, John, Esq. F.R.A.S. M.R.A.S. *Worcester.*
1828. Mar. 13.	Goldsmid, Sir Isaac Lyon, Bart. F.S.A. F.L.S. F.G.S. F.R.A.S. M.R.S.L. *Park-lodge, Regent's-park.*
1819. Jan. 29.	Gompertz, Benjamin, Esq. F.R.A.S. *Kennington-terrace, Vauxhall.*
1824. April 1.	Goodenough, Edmund, D.D. Dean of Wells. *The Deanery, Wells.*
1835. April 2.	† Gordon, James Alexander, M.D. 2 *Finsbury-square.*
1801. June 11.	Gordon, Lieut.-General Sir James Willoughby, Bart. K.C.B. G.C.H. *Near the Royal Hospital, Chelsea.*

Date of Election.	
1830. Dec. 9.	Gordon, Henry Percy, Esq. M.A. *Near the Royal Hospital, Chelsea.*
1821. Feb. 8.	Gordon, Thomas, Esq. *Zante, Greece.*
1820. Apr. 27.	Goulburn, Right Hon. Henry, D.C.L. M.P. 11 *and* 12 *Downing-street.*
1831. Dec. 22.	Graham, Right Hon. Sir James R. G., Bart. M.P. 31 *Hill-street; and Netherby, Cumberland.*
1836. Dec. 15.	Graham, Thomas, Esq., M.A. F.R.S.E. Professor of Chemistry in the University-college, London.—Acad. Reg. Sc. Berolin. et Manach. Corresp. 9 *Torrington-square.*
1840. May 21.	† Grant, Thomas Tassell, Esq. *Royal Clarence Victualling-yard, Portsmouth.*
1836. Feb. 4.	Grant, Robert Edmond, M.D. F.R.S.E. 10 *Seymour-place, North; Euston-square.*
1817. Nov. 20.	Granville, Augutus Bozzi, M.D. F.G.S. M.R.A.S. Acadd. Reg. Sc. Brux., et Taur.: Acadd. Luc. et Pat.: Socc. Geogr. Flor., Ital., Vienn., Sc. Nat. Neap., Athen. Ven., Philom. Paris., Socius.—Acad. Imp. Sc. Petr. Corresp. 109 *Piccadilly; and Rosemont, Great Missenden, Buckinghamshire.*
1832. Feb. 2.	Gravatt, William, Esq. 34 *Parliament-street.*
1839. Apr. 18.	Graves, John Thomas, Esq. M.A. Professor of Jurisprudence in the University-college, London. 8 *Gray's-inn-square.*
1832. Feb. 2.	Gray, John Edward, Esq. F.G.S. F.R.G.S. Imp. Hist. Nat. Mosc. Acadd. Lync. Romæ. Sci. Nat. Philad. et Hist. Nat. Boston., Socius. *British Museum.*
1825. Feb. 24.	Green, Joseph Henry, Esq., Professor of Anatomy to the Royal Academy, F.G.S. *Barnet.*
1807. Mar. 5.	Greenough, George Bellas, Esq. President of the Royal Geographical Society, F.L.S. F.G.S. M.R.A.S. *Grove-house, Regent's-park.*
1833. Feb. 7.	Greig, Woronzow, Esq. M.A. 14 *Lower Belgrave-street, Eaton-square.*
1830. June 10.	Gresswell, Rev. Richard, M.A. *Worcester-college, Oxford.*
1815. Feb. 16.	Grey, Sir Thomas, Knt. M.D. F.L.S. *Ramsgate.*
1841. Apr. 29.	† Grey, Thomas Philip, Earl de, Lord-Lieutenant of Ireland. 4 *St. James's-square; and West-park, Silsoe, Bedfordshire.*
1834. Apr. 10.	† Griffith, Edward, Esq. F.S.A. F.L.S. *Downshire-hill, Hampstead.*
1806. May 1.	Griffiths, John, Esq.
1840. Nov. 26.	† Grove, William Robert, Esq. M.A. 4 *Hare-court, Temple.*
1830. Apr. 22.	Grover, Captain John.
1839. June 20.	Guest, Edwin, Esq. 4 *King's-bench-walk, Temple.*
1830. June 10.	Guest, Sir Josiah John, Bart. F.G.S. 8 *Spring-gardens; and Dowlais Iron-works, Glamorganshire.*
1806. Jan. 16.	Guillemard, John Lewis, Esq. M.A. F.L.S. F.G.S. M.R.A.S. Soc. Amer. Philad. Socius. 27 *Gower-street; and Woodford, Essex.*
1839. Mar. 7.	Gulliver, George, Esq. *Regent's-park Barracks.*
1818. Jan. 15.	Gurney, Hudson, Esq. V.P.S.A. M.R.S.L. 9 *St. James's-square; and Keswick-hall, near Norwich.*
1827. May 24.	Guthrie, George James, Esq. 4 *Berkeley-street, Piccadilly.*
1801. May 7.	Hailstone, Rev. John, M.A. F.L.S. F.G.S. *Trumpington, Cambridgeshire.*
1810. Mar. 8.	Halford, Sir Henry, Bart. G.C.H. Physician to the Queen, Trust. Brit. Mus. President of the Royal College of Physicians. F.S.A. 16 *Curzon-street; and Wistow-hall, near Market-Harborough.*
1816. Mar. 28.	Hall, Basil, Captain in the Royal Navy, D.C.L. F.R.S.E. F.G.S. F.R.A.S. M.R.A.S. *Portsmouth; and Athenæum.*

Date of Election.		
1820. Apr. 27.	*	Hall, Sir John, Bart. F.R.S.E. F.G.S. *Donglass, Dunbar, Haddingtonshire.*
1832. Apr. 5.		Hall, Marshall, M.D. F.R.S.E. 14 *Manchester-square.*
1827. Nov. 22.		Hall, Thomas Henry, Esq. M.A. 49 *Tavistock-square.*
1821. Mar. 8.		Hallam, Henry, Esq. M.A. Trust. Brit. Mus. V.P.S.A. F.G.S. F.R.A.S. M.R.S.L. Instit. Reg. Sc. Paris. Socius. 24 *Wilton-crescent, Knightsbridge.*
1839. May 30.	†	Halliwell, James Orchard, Esq. Hon. M.R.I.A. F.S.A. L. & E. F.R.A.S. M.R.S.L., Soc. Reg. Antiq. Franc., Soc. Reg. Antiq. Septen. Hafn., Soc. Ethnol. Paris., Soc. Reg. Geogr. Paris., Soc. Asiatic. Paris., Corresp. *Islip, Oxfordshire.*
1835. Feb. 5.	†	Hamett, Sir John, Knt. M.D. *Hortulan-place, King's-road, Chelsea.*
1808. Jan. 14.		Hamilton and Brandon, Alexander, Duke of, F.S.A. 12 *Portman-square; and Hamilton-palace, Lanarkshire.*
1828. Jan. 17.		Hamilton, Rev. Henry Parr, M.A. F.R.S.E. F.G.S. F.R.A.S. *Trinity-college, Cambridge.*
1813. April 8.		Hamilton, William Richard, Esq. V.P.S.A. For. Sec. R.S.L. Acad. Reg. Sc. Berolin. Socius. Honor. 12 *Bolton-row, May-fair.*
1838. Jan. 18.	†	Hansler, Sir John J., Knt. F.S.A. 48 *Tavistock-square.*
1824. Apr. 29.		Harcourt, Rev. Wm. Venables Vernon, M.A. Hon. M.R.I.A. F.G.S. *Weldrake, near York.*
1838. April 5.	†	Hardwick, John, Esq. D.C.L. 5 *K, Albany, Piccadilly.*
1838. Dec. 8.		Hardwick, Philip, Esq. R.A. F.S.A. 60 *Russell-square.*
1839. Jan. 17.	†	Hardy, Peter, Esq. *Addiscombe, near Croydon.*
1823. May 29.		Harford, John Scandret, Esq. D.C.L.
1835. Feb. 5.	†	Harris, John Greathed, Esq. M.A. 2 *Old Palace-yard.*
1831. June 2.		Harris, William Snow, Esq. *Windsor Villas, Plymouth.*
1825. Feb. 17.		Harvey, Henry, Esq. F.R.A.S. *Hill-house, Streatham, Surrey.*
1835. April 2.	†	Harvey, Major-General Sir Robert John, C.B. K.T.S. K.S.B. F.S.A. *United Service Club; and Mousehold-house, near Norwich.*
1827. May 24.	†	Harwood, John, M.D. F.L.S. *St. Leonard's, Hastings.*
1812. Jan. 9.		Hasted, Rev. Henry, M.A. F.L.S. *Bury, Suffolk.*
1797. Mar. 9.		Hatchett, Charles, Esq. F.R.S.E. F.S.A. F.L.S. Instit. Reg. Sc. Paris. Corresp.—Acad. Reg. Sc. Monach., et Soc. Œcon. Petrop., Socius. *Belle-Vue-house, Chelsea; and Bollington, Lincolnshire.*
1821. Nov. 15.		Haughton, Sir Graves Chamney, K.H. M.A. Hon. M.R.I.A. M.R.A.S., Instit. Reg. Sc. Paris. Socius, Acad. Reg. Berolin. Corresp. 14 *Grafton-street, Bond-street.*
1834. Dec. 18.		Hawkins, Bissett, M.D. 30 *Golden-square.*
1821. May 24.	*	Hawkins, Edward, Esq. F.S.A. F.L.S. *British Museum.*
1791. May 5.		Hawkins, John, Esq. *Quay-house, Devonshire.*
1830. June 10.		Hawkins, John Heywood, Esq. M.A. F.G.S. 8 *Suffolk-street; and Bignor-park, Petworth, Sussex.*
1835. Nov. 19.	†	Hawkins, Rev. William B. L., M.A. 28 *Great Marlborough-street.*
1814. Mar. 3.		Hay, Robert William, Esq. F.S.A.
1818. May 28.	*	Heath, George Crauford, Esq. *Cambridge.*
1791. Feb. 24.		Heberden, William, M.D. Coll. Reg. Med. Socius. 8 *Sackville-street.*
1834. Apr. 10.		Henry, William Charles, M.D. *Haffield, near Ledbury, Herefordshire.*
1840. April 9.	†	Henderson, Thomas, Esq. F.R.A.S. *Edinburgh.*

Date of Election.		
1840. Feb. 27.	†	Henwood, William Jory, Esq. 4 *Clarence-street, Penzance.*
1813. May 27.		Herschel, Sir John Frederick William, Bart. D.C.L. M.A. F.R.S.E. Hon. M.R.I.A. F.G.S. M.C.P.S. Instit. Reg. Sc. Paris. Corresp.—Acadd. Imp. Sc. Petrop., et Reg. Sc. Brux.: Hafn., Harl. et Neap.: Acadd. Lync, Romæ, Pat., Bonon., Panorm., Gioen. Catan. et Divion. ex intim.: Socc. Philom. Paris., Ital. Mut., Helvet., Socius.—Acad. Reg. Sc. Berol., Soc. Reg. Sc. Gotting. Corresp. *Collingwood, near Hawkhurst, Kent.*
1839. Feb. 7.		Heywood, James, Esq. F.S.A. 37 *Athenæum.*
1820. Mar. 23.		Higman, Rev. John Philip, M.A. F.G.S. F.R.A.S. *Trinity-college, Cambridge.*
1839. Jan. 10.	†	Hilton, John, Esq. *St. Thomas's-street, Southwark.*
1809. Dec. 21.		Hoare, Charles, Esq. F.S.A. 37 *Fleet-street.*
1814. May 19.		Hobhouse, Right Hon. Sir John Cam, Bart. M.A. M.P. 42 *Berkeley-square.*
1811. June 27.		Hoblyn, Thomas, Esq. F.L.S.
1841. Feb. 18.		Hodgkinson, Eaton, Esq. 17 *Salford-crescent, Manchester.*
1831. Apr. 14.		Hodgson, Joseph, Esq. *Birmingham.*
1810. July 5.	*	Hodgson, Robert, D.D. Dean of Carlisle, F.G.S. 15 *Grosvenor-street; and Hillingdon, Uxbridge.*
1839. June 20.	†	Hogg, John, Esq. M.A. F.L.S. F.C.P.S. 12 *King's-bench-walk, Inner Temple; and Norton-house, Stockton-upon-Tees.*
1837. Jan. 19.		Holland, Charles, M.D. 16 *Queen-street, May-fair.*
1815. Jan. 19.		Holland, Henry, M.D. F.G.S. Coll. Reg. Med. Socius. 25 *Brook-street.*
1826. Feb. 2.		Holman, James, Esq. Lieutenant in the Royal Navy, F.L.S. *Windsor.*
1825. Apr. 21.		Home, Sir Everard, Bart. Captain in the Royal Navy, F.S.A. H.M. Ship, North Star.
1812. Jan. 9.		Hooker, Sir William Jackson, K.H. LL.D. Hon. M.R.I.A. F.S.A. F.L.S. F.G.S. Acad. Cæs. Nat. Cur. Socius. *Kew.*
1834. June 5.	†	Hope, Rev. Frederick William, M.A. F.L.S. 56 *Upper Seymour Street.*
1810. May 31.		Hope, Thomas Charles, M.D., Professor of Chemistry, Edinburgh, V.P.R.S.E. Hon. M.R.I.A. *Edinburgh.*
1837. June 1.	†	Hopkins, William, Esq. M.A. *St. Peter's-college, Cambridge.*
1841. May 20.		Hoppus, Rev. John, LL.D. Ph. D. Professor of Philosophy and Logic in the University-college, London. 29 *Camden-street, Camden-town.*
1834. Feb. 6.		Horne, James, Esq. *Clapham-common.*
1813. Nov. 11.		Horner, Leonard, Esq. F.R.S.E. V.P.G.S. Soc. Batav. Sc. Harlem. Socius. 2 *Bedford-place.*
1828. Jan. 10.	†	Horsfield, Thomas, M.D. F.L.S. F.G.S. M.R.A.S. Acad. Cæs. Nat. Cur. Socius. 20 *Stoncfield-street, Islington.*
1794. April 3.		Howard, Colonel Hon. Fulk Greville, F.S.A. 16 *Grosvenor-square.*
1821. Mar. 8.		Howard, Luke, Esq. *Bruce-grove, Tottenham; and Ackworth-villa, Pomfret.*
1834. Apr. 10.		Hudson, Robert, Esq. F.G.S. *Clapham-common.*
1818. Jan. 8.		Hume, Joseph, Esq. 6 *Bryanstone-square.*
1819. Nov. 11.		Hunt, Rev. George, M.A. F.S.A. *Egg Buckland, near Plymouth.*
1837. April 6.	†	Hunter, Robert, Esq. F.S.A. *Highgate.*
1819. Nov. 18.		Hustler, Rev. James Devereux, B.D. *Euston-rectory, near Thetford, Norfolk.*
1829. Mar. 19.		Hutchinson, Lieut.-Colonel George. *Cedars, Putney.*
1840. June 4.	†	Hutton, William, Esq. *Newcastle-upon-Tyne.*

Date of Election.	
1838. May 31.	Hymers, Rev. John, D.D. *St. John's-college, Cambridge.*
1813. Mar. 4.	Inglis, Sir Robert Harry, Bart. LL.D. M.P. Trust. Brit. Mus. F.S.A. F.R.A.S. 7 *Bedford-square; and Battersea-rise, Clapham.*
1807. Apr. 23.	Jacob, William, Esq. Instit. Sc. Paris. Corresp. 31 *Cadogan-place, Sloane-street.*
1826. May 25.	Jameson, Robert, Esq., Regius Professor of Natural History, Edinburgh. F.R.S.E. Hon. M.R.I.A. F.L.S. F.G.S. Acad. Reg. Sc. Neap.: Socc. Reg. Sc. Dan., Imp. Hist. Nat. Mosc. Hist. Nat. Veter., et Paris., Philom. Paris., Amer. Philad., Phil. et Hist. Nov.-Ebor., Socius.—Acad. Reg. Sc. Berol., Corresp. *Edinburgh.*
1841. Jan. 7.	† Jeffereys, Julius, Esq. *Clapham.*
1840. April 2.	† Jeffreys, John Gwyn, Esq. *Swansea.*
1841. Feb. 18.	† Jenkins, Sir Richard, G.C.B. 7 *Mansfield-street, Portland-place; and Bickton-hall, Shrewsbury.*
1821. Mar. 1.	Jennings, Rev. Philip, D.D. *Hampstead-green.*
1838. Mar. 15.	† Jervis, Thomas Best, Esq. Major, East India Company's Engineers. F.G.S. F.R.A.S. 9 *Regent's Villas, Avenue-road, Regent's-park.*
1842. May 5.	† Jesse, John, Esq. F.R.A.S. F.L.S. *Ardwick, near Manchester.*
1842. Mar. 10.	† Johnson, Cuthbert William, Esq. 14 *Gray's-inn-square.*
1836. Mar. 10.	† Johnson, Edward John, Esq. Captain, Royal Navy. 18 *Clement's Inn.*
1838. Jan. 18.	Johnson, Rev. George Henry Sacheverell, M.A. Professor of Moral Philosophy in the University of Oxford. *Queen's-college, Oxford.*
1810. Nov. 22.	Johnston, Right Hon. Sir Alexander, Knt. F.S.A. V.P.R.A.S. 19 *Great Cumberland-place; and York-house, Twickenham.*
1837. June 15.	† Johnston, James F. W., Esq., M.A. F.R.S. Ed. Professor of Chemistry and Mineralogy in the University of Durham.
1835. June 4.	† Jones, Thomas, Esq. F.R.A.S. 62 *Charing-cross.*
1840. Apr. 30.	† Jones, Thomas Wharton, Esq. 26 *George-street, Hanover-square.*
1840. Nov. 19.	Kater, Edward, Esq. F.G.S. M.R.I.A. *Parthenon Club, Regent-street; and Mexborough, Yorkshire.*
1838. Dec. 6.	† Kelland, Rev. Philip, M.A. F.R.S.E. M.C.P.S. Professor of Mathematics in the University of Edinburgh.
1841. Mar. 18.	† Kerrison, Robert Masters, M.D. 12 *New Burlington-street.*
1822. Mar. 28.	Kidd, John, M.D., Regius Professor of Medicine, and Aldrich's Professor of Anatomy, Oxford, F.G.S. Coll. Reg. Med. Socius. *Oxford.*
1834. Dec. 18.	Kiernan, Francis, Esq. 33 *Beaumont-street, Devonshire-place.*
1824. Feb. 26.	King, Philip Parker, Esq. Captain in the Royal Navy, F.L.S. *Dunheved, New South Wales.*
1818. Mar. 5.	Kirby, Rev. William, M.A. F.L.S. F.G.S. Acad. Cæs. Nat. Cur., et Soc. Nat. Scrutat. Berol., Socius. *Barham, near Ipswich.*
1841. May 20.	† Knight, Henry Gally, Esq. M.P. 69 *Grosvenor-street.*
1830. Mar. 4.	Knowles, Sir Francis Charles, Bart. M.A. 2 *Harcourt-buildings, Temple.*
1810. Jan. 18.	* Konig, Charles, Esq. K.H. Hon. M.R.I.A. F.L.S. Acad. Reg. Sc. Monach. Socius.—Acad. Imp. Sc. Petrop., et Soc. Reg. Gotting. Corresp.—Soc. Imp. Hist. Nat. Mosc. Socius.—Acad. Panorm., et Soc. Veterav., Sodalis. *British Museum.*
1811. April 4.	Lansdowne, Henry, Marquis of, D.C.L. Trust. Brit. Mus. M.R.S.L. 52 *Berkeley-square; and Bowood-park, Wiltshire.*
1801. Apr. 30.	Latham, John, M.D. F.L.S. Coll. Reg. Med. Socius. *Broadwall-hall, Cheshire.*
1813. Nov. 11.	Lawrence, William, Esq. 18 *Whitehall-place.*

Date of Election.	
1840. May 21.	† Lawson, Henry, Esq. *Hereford.*
1815. Apr. 13.	Leake, Lieut.-Colonel William Martin, M.R.S.L. Acad. Reg. Sc. Berol. Socius. Honor. —Instit. Reg. Paris., Corresp. 50 *Queen Anne-street.*
1831. Feb. 24.	Lee, John, LL.D. Treas. R.A.S. 5 *College, Doctor's-commons; and Hartwell-house, near Aylesbury, Buckinghamshire.*
1830. Mar. 25.	Lee, Robert, M.D. Coll. Reg. Med. Socius. 14 *Golden-square.*
1820. Nov. 16.	Lefevre, John George Shaw, Esq. M.A. Vice-Chancellor of the University of London. *Board of Trade, Whitehall.*
1817. June 12.	Legh, Thomas, Esq. D.C.L. *Lyme-park, Cheshire.*
1822. May 23.	Lemon, Sir Charles, Bart. 46 *Charles-street, Berkeley-square; and Carclew, near Falmouth, Cornwall.*
1836. May 5.	† Lewis, Thomas Locke, Esq. Captain Royal Engineers, F.G.S. *Ibsley-cottage, Exeter.*
1811. Mar. 7.	Lincoln, John Kaye, Lord Bishop of. *Cambridge; and Buckden-palace, Huntingdonshire.*
1828. Jan. 17.	† Lindley, John, Phil. D. F.L.S. Acad. Reg. Berol. Corresp.; Acad. Cæs. Nat. Cur., Socc. Physiogr. Lund. Linn. Holm., Socius.—Soc. Batav. Sc., Lyc. Nat. Hist. Nov.-Ebor., Socius Honor.—Prof. Bot. Univ. Coll. Lond. 21 *Regent-street.*
1832. Feb. 2.	Lister, Joseph Jackson, Esq. *Upton, Essex.*
1841. May 13.	† Liston, Robert, Esq. 5 *Clifford-street, New Bond-street.*
1836. Feb. 4.	Llewelyn, John Dillwyn, Esq. *Penllergare, Glamorgan.*
1818. Mar. 12.	Lloyd, Edward, Esq. Captain in the Royal Navy.
1830. Mar. 11.	† Lloyd, John Augustus, Esq. *Mauritius.*
1834. Apr. 10.	Lloyd, Rev. William Forster, M.A. *Missenden, Bucks.*
1836. Jan. 21.	Lloyd, Rev. Humphrey, M.A. M.R.I.A. *Dublin.*
1838. Feb. 22.	† Locke, Joseph, Esq. 6 *Chester-terrace, Regent's-park.*
1811. Dec. 5.	Locker, Edward Hawke, Esq. F.S.A. *Royal Hospital, Greenwich.*
1841. Nov. 25.	† Lovelace, William King, Earl of. 10 *St. James's-square; Ockham-park, Ripley, Surrey; and Ashley-combe, Postock, Somerset.*
1834. Dec. 18.	† Lowe, George, Esq. 39 *Finsbury Circus.*
1810. July 5.	Lowther, William Viscount, F.S.A. 14 *Carlton-terrace; and Lowther-castle, near Penrith.*
1829. Jan. 15.	Lubbock, Sir John William, Bart. M.A.—Vice-President and Treasurer.—F.L.S. F.R.A.S. M.R.A.S. 23 *St. James's-place; Mitcham-grove, Surrey; and Highelms, Farnborough, Kent.*
1826. Feb. 2.	Lyell, Charles, Jun. Esq. M.A. F.L.S. F.G.S. 16 *Hart-street, Bloomsbury.*
1826. Apr. 13.	Lyndhurst, John Singleton, Lord, D.C.L. 25 *George-street, Hanover-square.*
1840. Apr. 30.	† Lyttleton, George William, Lord. 39 *Grosvenor-place; and Hagley-park, near Stourbridge, Worcestershire.*
1811. Feb. 21.	Macartney, James, M.D. F.L.S. *Trinity-college, Dublin.*
1816. Mar. 14.	MacGrigor, Sir James, Bart. F.R.S.E. Coll. Reg. Med. Socius. *Camden-hill, Kensington.*
1824. Apr. 29.	Macintosh, Charles, Esq. *Glasgow.*
1815. Apr. 13.	Mackenzie, Sir George Steuart, Bart. F.R.S.E. *Coul, Ross-shire.*
1817. May 15.	Mackie, Rev. John William, M.A. 27 *Upper Baker-street.*
1827. June 14.	Mackinnon, William Alexander, Esq. M.A. F.S.A. F.G.S. 4 *Hyde-park-place; and Newton-park, Lymington, Hants.*
1839. May 30.	† Macmurdo, Gilbert Wakefield, Esq. *St. Thomas's Hospital; and 7 New Broad-street.*
1831. Dec. 8.	Maclear, Thomas, Esq. F.R.A.S. Astronomer Royal at the Cape of Good Hope.

Date of Election.	
1809. Jan. 19.	MacLeay, Alexander, Esq. F.L.S. Acad. Reg. Sc. Holm., Socius, et Acad. Reg. Sc. Taurin. Corresp. *Sydney, New South Wales.*
1838. April 5.	† Macneill, John, Esq. F.R.A.S. M.R.I.A. 9 *Whitehall-place.*
1832. Feb. 2.	† Madden, Sir Frederick, K.H. Hon. M.R.I.A. F.S.A. Soc. Reg. Antiq. Septen. Hafn., Socius. *British Museum.*
1817. June 12.	Maddy, Rev. John, D.D. F.S.A. F.R.A.S. *Somertown, Bury St. Edmunds.*
1819. June 24.	Magrath, Sir George, K.H. M.D. M.R.I.A. F.L.S. F.G.S. *Plymouth.*
1827. Mar. 22.	† Mahon, Philip Henry, Viscount, D.C.L. M.P. 41 *Grosvenor-place; and Chevening-place, Kent.*
1839. Apr. 18.	† Maitland, Rev. Samuel Roffy. *Lambeth-palace.*
1829. May 28.	Maitland, Ebenezer Fuller, Esq. F.S.A. *Henley-on-Thames, Oxfordshire.*
1821. June 28.	* Majendie, Ashurst, Esq. F.G.S. *Hedingham-castle, Essex.*
1840. Apr. 30.	† Malcolmson, John Grant, M.D. *India.*
1831. May 12.	Manby, Captain George William. *Yarmouth.*
1825. Jan. 20.	Mangles, James, Esq. Captain in the Royal Navy. 66 *Cambridge-terrace, Edgware-road.*
1825. Nov. 24.	Mantell, Gideon Algernon, Esq. LL.D. F.L.S. F.G.S. Coll. Reg. Med. Socius. Soc. Philom. Paris. Corresp., et Acadd., Philad. et Connect. Socius Honor. *Crescent-lodge, Clapham-common.*
1836. Jan. 28.	Marcet, Francis, Esq. *Geneva.*
1816. Mar. 28.	Markland, James Heywood, Esq. F.S.A. *Bath.*
1819. May 13.	Marryatt, Frederick, Esq. Captain in the Royal Navy, F.L.S. *Wimbledon.*
1832. Feb. 2.	Mauley, Lord de. 24 *George-street, Hanover-square; and Canford-house, near Wimborne, Dorset.*
1829. Feb. 26.	Maxwell, John, Esq. *Pollock, Renfrewshire.*
1818. Jan. 29.	Mayne, John Thomas, Esq. F.S.A. Soc. Phil. Neap. Socius. 2 *Harcourt-buildings, Temple; and Teffont-house, Salisbury.*
1827. Mar. 1.	† Mayo, Rev. Charles, B.D. F.S.A. *Colesgrove, near Cheshunt, Hertfordshire.*
1828. Apr. 17.	† Mayo, Herbert, Esq.
1835. June 4.	† Mayo, Thomas, M.D. Coll. Reg. Med. Socius. 56 *Wimpole-street.*
1841. Feb. 25.	† Melbourne, William, Viscount. 39 *South-street, Grosvenor-square; and Brocket-hall, Herts.*
1817. May 15.	Melville, Robert, Viscount, K.T. F.R.A.S. 3 *Somerset-place; and Melville-castle, Edinburgh.*
1841. Jan. 14.	† Melville, James Cosmo, Esq. *East India House.*
1838. May 3.	† Merewether, Rev. John, D.D. Dean of Hereford, F.S.A.
1827. May 24.	Miller, Lieut.-Colonel George, C.B. 2 *Stone-buildings, Lincoln's-inn.*
1838. Feb. 8.	Miller, William Hallows, Esq. M.A. *St. John's-college, Cambridge.*
1836. Mar. 3.	Minto, Gilbert Elliot Murray Kynynmound, Earl of. F.R.A.S. *Minto-castle, Roxburghshire.*
1835. Nov. 26.	Molesworth, Sir William, Bart. M.P. 1 *Lowndes-square; and Pencarrow, Cornwall.*
1841. Apr. 29.	† Monteagle, Thomas, Lord. 37 *Lower Brook-street; and Exchequer-office, Whitehall.*
1836. June 16.	Montefiore, Sir Moses, Knt. 7 *Grosvenor-gate, Park-lane; and East Cliff-lodge, Ramsgate.*
1806. May 6.	Moor, Major Edward, F.S.A. M.R.A.S. *Bealings, near Woodbridge, Suffolk.*
1835. April 2.	† Moore, George, Esq. F.S.A. 64 *Lincoln's-inn-fields.*
1827. Feb. 8.	Moreau, César, Esq. Acadd. Reg. Divion., Burd., et Masil., Socius. *Paris.*
1835. April 2.	† Morgan, Arthur, Esq. 26 *New Bridge-street, Blackfriars.*

Date of Election.		
1816. May 30.		Morgan, Charles, Esq. F.S.A. F.L.S. *Pall-mall; and Tredegar-house, near Newport, Monmouthshire.*
1832. Feb. 2.	†	Morgan, Octavius S., Esq. M.A. F.S.A. 70 *Pall-mall; and Tredegar-park, Monmouthshire.*
1819. Feb. 4.		Morier, James, Esq. 22 *Charles-street, Berkeley-square.*
1831. Mar. 10.		Morris, John Carnac, Esq.
1842. Mar. 3.	†	Morison, Major-General William, C.B. F.R.S.E. *Oriental-club.*
1839. Feb. 7.	†	Moseley, Rev. Henry, M.A. Professor of Natural Philosophy and Astronomy, King's-college, London. *Wandsworth.*
1830. Feb. 18.		Moss, Joseph William, M.B. *Dudley.*
1822. Dec. 5.		Mudge, Rich. Zachariah, Esq. Lieut.-Col. Royal Engineers. *Beechwood, Plympton, Devon.*
1826. April 6.		Murchison, Roderick Impey, Esq. Hon. M.R.I.A. President of the Geological Society. 16 *Belgrave-square.*
1805. July 4.		Murdoch, Thomas, Esq. F.S.A. 8 *Portland-place.*
1823. June 19.		Murray, Right Hon. Sir George, G.C.B. G.C.H. K.T.S. 5 *Belgrave-square; and Bleaden, Perthshire.*
1826. Mar. 16.		Mylne, William Chadwell, Esq. F.R.A.S. *New River-head.*
1820. May 18.	*	Napier, Henry, Esq. Captain in the Royal Navy. *Florence.*
1817. June 12.		Napier, Macvey, Esq. F.R.S.E. *Edinburgh.*
1840. June 18.	†	Narrien, John, Esq. F.R.A.S., Professor of Mathematics in the Royal Military College, Sandhurst.
1814. May 5.		Neave, Sir Thomas, Bart. F.S.A. 6 *Albemarle-street; and Dagnam-park, Rumford, Essex.*
1842. Jan. 6.		Newbold, Thomas John, Esq. Lieutenant, E.I.C.S. *Madras.*
1833. Feb. 7.	†	Nolan, Rev. Frederick, LL.D. M.R.S.L. *Prittlewell, Essex.*
1830. May 27.		Northampton, Spencer Joshua Alwyne, Marquis of.—PRESIDENT.—Trust. Brit. Mus., F.S.A. Hon. M.R.I.A. F.G.S. 145 *Piccadilly; and Castle Ashby, Northampton.*
1823. May 1.		Northumberland, Hugh, Duke of, K.G. M.A. Trust. Brit. Mus. F.S.A. F.L.S. F.G.S. *Northumberland-house, Strand.*
1840. June 4.	†	Norwich, Edward Stanley, Lord Bishop of. 38 *Lower Brook-street; and Palace, Norwich.*
1826. Feb. 2.	†	Ogle, James Adey, M.D. F.R.A.S. Coll. Reg. Med. Socius. Lord Lichfield's, and Aldrich's Professor of Medicine, Oxford. *Oxford.*
1786. Nov. 16.		Oldershaw, John, B.D. Archdeacon of Norfolk. *Harlestone, Norfolk.*
1835. June 4.		Oliveira, Benjamin, Esq. F.S.A. 8 *Upper Hyde-park-street.*
1819. Feb. 18.		Onley, Charles Savill, Esq. F.S.A. F.L.S. 22 *Great George-street, Westminster; and Stiested-hall, Essex.*
1824. Mar. 4.		Orford, Horatio, Earl of. *White's Club; and Wolterton-park, Norfolk.*
1819. Feb. 25.		Ormerod, George, Esq. D.C.L. F.S.A. F.G.S. *Sudbury-park, Gloucestershire.*
1839. Apr. 11.	†	Ormsby, H. Alexander, Esq. Lieutenant, Indian Navy. *India.*
1817. Dec. 18.		Ouseley, Right Hon. Sir Gore, Bart. G.C.H. F.S.A. M.R.A.S. M.R.S.L. Acad. Imp. Sc. Petrop. Socius. 41 *Upper Brook-street; and Woolmers, Hertfordshire.*
1838. May 3.		Outram, Benjamin Fonseca, M.D. F.R.G.S. 1 *Hanover-square.*
1834. Dec. 18.		Owen, Richard, Esq. F.G.S. F.L.S. Instit. Sc. Paris. Corresp. *Royal College of Surgeons, Lincoln's-inn-fields.*
1821. Nov. 15.		Palgrave, Sir Francis, K.H. Deputy Keeper of Her Majesty's Records. *Roll's-yard, Chancery-lane; and Hampstead-green.*

Date of Election.	
1831. Dec. 8.	Palmer, Henry Robinson, Esq. 2 *Great George-street, Westminster.*
1821. June 21.	* Paris, John Ayrton, M.D. F.L.S. Coll. Reg. Med. Socius. 28 *Dover-street.*
1824. Mar. 4.	Parish, Sir Woodbine, K.C.H. F.S.A. F.G.S. *Naples.*
1815. June 1.	Parker, Thomas Lister, Esq. F.S.A. F.L.S. 34 *Mount-street.*
1840. Feb. 6.	† Parkinson, John, Esq. 80 *Cambridge-terrace, Hyde-park.*
1812. Feb. 20.	Parry, Charles Henry, M.D. *Bath.*
1821. Feb. 15.	Parry, Sir William Edward, Knt. D.C.L. Captain in the Royal Navy. Hon. M.R.I.A. F.R.A.S. Acad. Imp. Sc. Petrop. Socius. 2 *New-street, Spring-gardens.*
1837. Feb. 23.	† Partridge, Richard, Esq. 17 *New-street, Spring-gardens.*
1816. Mar. 7.	Pasley, Major-General Charles William, C.B. Royal Engineers. F.R.A.S. F.G.S. *Board of Trade, Whitehall.*
1818. Jan. 29.	Peacock, Very Rev. George, D.D. Dean of Ely. F.G.S. F.R.A.S. *Deanery, Ely.*
1833. Dec. 5.	Pearson, Sir Edwin, K.H. M.A. 5 *Gloucester-terrace, Regent's-park.*
1819. July 1.	Pearson, Rev. William, LL.D. F.R.A.S. 6 *Compton-terrace, Islington; and South Kilworth, near Welford, Northamptonshire.*
1826. Mar. 9.	Pearson, Sir William, Knt. M.D. 16 *Hanover-square.*
1832. Feb. 2.	Pechell, Sir Samuel John Brooke, Bart. Captain in the Royal Navy. 27 *Hill-street, Berkeley-square.*
1822. Dec. 5.	Peel, Right Hon. Sir Robert, Bart. D.C.L. Trust. Brit. Mus. F.S.A. *Whitehall-gardens; and Drayton-Manor, Fazeley, Staffordshire.*
1835. April 2.	† Pelly, Sir John Henry, Bart. *Trinity-house.*
1813. Feb. 11.	Pemberton, George, Esq. 50 *Park-street; and Bainbridge Holme, Durham.*
1827. May 24.	Pendarves, Edward William Wynne, Esq. M.A. F.G.S. 36 *Eaton-place, Belgrave-square; and Pendarves, Truro, Cornwall.*
1824. Nov. 18.	Penn, Richard, Esq. 6 *Whitehall.*
1792. Nov. 15.	Pennant, David, Esq. F.L.S. *Downing, near Holywell, Flintshire.*
1808. Jan. 28.	Pepys, William Hasledine, Esq. F.L.S. *Poultry.*
1838. May 3.	† Pereira, Jonathan, M.D. F.L.S. *Finsbury-square.*
1807. Dec. 10.	Petit, Louis Hayes, Esq. M.A. F.S.A. F.L.S. F.G.S. F.R.A.S. M.R.S.L. 9 *New-square, Lincoln's-inn.*
1817. Mar. 6.	Petre, William Francis Henry, Lord. 3 *Mansfield-street; and Thorndon-hall, near Brentwood, Essex.*
1827. Feb. 1.	† Pettigrew, Thomas Joseph, Esq. F.S.A. F.L.S. M.R.A.S. Univ. Gotting. Phil Doct.—Acad. Reg. Divion. Socius. 8 *Saville-street.*
1815. June 15.	* Phelps, John Delafield, Esq. F.S.A. *Chevenage-house, Tetbury, Gloucestershire.*
1826. Apr. 11.	Philip, Alexander Philip Wilson, M.D. F.R.S.E. 18 *Cavendish-square.*
1840. Feb. 13.	† Phillimore, Joseph, LL.D. 10 *College, Doctors'-commons; and* 22 *Portman-street.*
1819. Jan. 29.	Phillipps, Sir Thomas, Bart. M.A. F.S.A. F.G.S. Hon. M.R.S.L. *Middle-hill, Worcestershire.*
1834. Dec. 18.	Phillips, Benjamin, Esq. 17 *Wimpole-street, Cavendish-square.*
1834. Apr. 10.	† Phillips, John, Esq. F.G.S. *York.*
1822. Mar. 14.	* Phillips, Richard, Esq. F.R.S.E. 6 *Craig's-court, Charing-cross; and Camberwell-green.*
1820. Apr. 20.	Phillips, Thomas, Esq. R.A. F.S.A. 8 *George-street, Hanover-square.*
1791. Mar. 10.	Pocock, Sir George, Bart. *Bransgore-house, Ringwood, Hampshire.*
1829. April 9.	Pole, William, Esq. M.A. 3 *Stone-buildings, Lincoln's-inn.*

Date of Election.	
1829. April 9.	Pollock, David, Esq. F.R.A.S. M.R.A.S. M.R.S.L. 26 *Oxford-square, Hyde-park; and* 3 *Pump-court, Temple.*
1816. Feb. 29.	Pollock, Sir Frederick, K.H. M.A. F.S.A. F.G.S. M.P. *Queen-square-house, Guildford-street.*
1838. Jan. 18.	† Porter, George Richardson, Esq. M.R.A.S. Instit. Roy. Sc. Paris. Corresp. *Board of Trade, Whitehall.*
1837. June 8.	Portlock, Joseph Ellison, Esq. Captain of Royal Engineers, F.G.S. *Cork.*
1824. May 13.	Powell, Rev. Baden, M.A. F.R.A.S. Savilian Professor of Geometry, Oxford. *Oxford.*
1842. Jan. 27.	† Pratt, Samuel Peace, Esq. F.L.S. F.G.S. 11 *Aldermanbury; and Bath.*
1827. Feb. 8.	Prichard, James Cowles, M.D. Hon. M.R.I.A. Instit. Sc. Paris. Corresp. *Bristol.*
1840. Feb. 6.	† Pritchard, Rev. Charles, M.A. *Clapham.*
1819. Mar. 11.	* Prout, William, M.D. Coll. Reg. Med. Socius. 40 *Sackville-street.*
1818. April 9.	Prudhoe, Algernon, Lord, F.S.A. President of the Royal Institution of Great Britain. *Whitehall-gardens; and Stanwick-park, Darlington, Yorkshire.*
1830. May 27.	Pusey, Philip, Esq. 35 *Grosvenor-square; and Pusey-house, near Farringdon, Berks.*
1819. June 24.	Ramsbottom, John, Esq. M.P. *Union Club; and Grove-house, near Windsor.*
1814. Dec. 15.	Rashleigh, William, Esq. F.L.S. M.P. 3 *Cumberland-terrace, Regent's-park; and Menabilly-house, Foy, Cornwall.*
1837. Jan. 19.	† Rastrick, John Urpath, Esq. 46 *Eaton-square.*
1838. Feb. 8.	Reade, Rev. Joseph Bancroft, M.A. *Stone Vicarage, Aylesbury.*
1817. June 12.	Reeves, John, Esq. F.L.S. F.R.A.S. *Clapham.*
1834. Feb. 6.	Reeves, John Russell, Esq. F.L.S. *Clapham.*
1839. Feb. 21.	† Reid, Lieut.-Colonel William, C.B. Royal Engineers, Governor of Bermuda.
1822. Mar. 21.	Rennie, George, Esq.—VICE-PRESIDENT.—Hon. M.R.I.A. 21 *Whitehall-place.*
1823. June 12.	Rennie, Sir John, Knt. 15 *Whitehall-place.*
1825. Feb. 24.	Richardson, John, M.D. F.L.S. Acad. Sc. Nat. Philad., Geogr. Paris. Corresp.—Socc. Hist. Nat. Montreal, Lit. et Phil. Quebec, Hist. Nat. Boston, Socius Honor. *Haslar-hospital, Gosport.*
1840. April 2.	† Richmond, Charles Gordon Lennox, Duke of, K.G. President of the Royal Agricultural Society. 51 *Portland-place; and Goodwood, near Petworth, Sussex.*
1820. Mar. 23.	Ricketts, Charles Milner, Esq. F.G.S. *Lima.*
1842. Jan. 13.	Riddell, Charles James Buchanan, Esq. Lieut. Royal Artillery. *Woolwich.*
1839. Apr. 25.	Rigg, Robert, Esq. *Greenford, Middlesex.*
1828. Apr. 17.	Ripon, Frederick John, Earl of. 4 *St. James's-square.*
1836. Feb. 11.	Robertson, Dr. Archibald. *Northampton.*
1796. Nov. 17.	Rogers, Samuel, Esq. F.S.A. 22 *St. James's-place.*
1839. Dec. 5.	Rogers, John, jun. Esq. *Vine-lodge, near Sevenoaks, Kent.*
1815. Mar. 16.	Roget, Peter Mark, M.D.—SECRETARY.—F.G.S. F.R.A.S. V.P.S.A. Coll. Reg. Med. Socius. 39 *Bernard-street, Russell-square.*
1831. June 9.	Ros, Hon. Frederick De, Captain in the Royal Navy, F.R.A.S. *Naval Club, New Bond-street.*
1834. June 5.	Rose, Sir George, Knt. 4 *Hyde-park-gardens.*
1819. April 1.	Rosebery, Archibald John, Earl of, K.T. 139 *Piccadilly; and Dalmeney-park, Linlithgow.*
1822. June 13.	Ross, Captain Daniell. *India.*

Date of Election.	
1828. Dec. 11.	Ross, James Clark, Esq. Captain in the Royal Navy, F.L.S. F.R.A.S. Soc. Reg. Sc. Hafn. Socius.
1831. Dec. 8.	Rosse, William, Earl of.—Vice-President.—F.R.A.S. *Birr-castle, King's County, Ireland.*
1839. Dec. 12.	† Roupell, George Leith, M.D. 15 *Welbeck-street.*
1837. April 6.	† Royle, John Forbes, M.D. F.L.S. F.G.S. F.R.A.S. Professor of Materia Medica and Therapeutics, King's-college. 4 *Bulstrode-street, Manchester-square.*
1805. Jan. 31.	Rudge, Edward, Esq. F.S.A. F.L.S. F.H.S. F.R.G.S. 44 *Wimpole-street; and Abbey Manor-house, Evesham, Worcestershire.*
1821. June 7.	Russell, Jesse Watts, D.C.L. F.S.A. F.L.S. F.G.S. *Ilam-hall, Staffordshire.*
1818. Apr. 16.	Sabine, Lieut.-Colonel Edward, Royal Artillery, F.R.A.S. Acad. Imp. Sc. Petrop. Socc. Reg. Sc. Norv., et Phil. Nov.-Ebor., Socius.—Acad. Reg. Sc. Brux.: Socc. Reg. Sc. Gotting., et Geogr. Paris., Corresp. *Athenæum; and Woolwich.*
1832. Dec. 6.	Sanford, Edward Ayshford, Esq. *Nynehead, Somerset.*
1833. Apr. 18.	† Saunders, Rev. Augustus Page, M.A. *Charter-house-school.*
1822. June 27.	Sawbridge, Henry Barne, Esq.
1824. June 17.	Scoresby, Rev. William, D.D. F.R.S.E. Instit. Reg. Sc. Paris. Corresp. Vicar of Bradford, Yorkshire.
1800. Jan. 16.	Scott, John Corse, Esq. *Edinburgh.*
1826. Dec. 7.	Scrope, George Poulett, Esq. M.P. F.G.S. 13 *Belgrave-square; and Castle Combe, Chippenham, Wiltshire.*
1824. Jan. 15.	† Scudamore, Sir Charles, Knt. M.D. 6 *Wimpole-street.*
1786. Mar. 9.	Seale, Rev. John Barlow, D.D. F.S.A. *Stisted, near Braintree.*
1821. Feb. 1.	Sedgwick, Rev. Adam, M.A. Hon. M.R.I.A. F.G.S. F.R.A.S. Woodwardian Lecturer, Cambridge. *Cambridge.*
1831. Jan. 13.	Selkirk, Thomas James, Earl of. *St. Mary's Isle, Kirkcudbright.*
1841. June 17.	† Seymour, Edward James, M.D. 13 *Charles-street, Berkeley-square.*
1840. May 7.	† Sharp, William, Esq. F.G.S. F.R.A.S. *Bradford, Yorkshire.*
1839. May 9.	Sharpey, William, M.D. F.R.S.E. Professor of Anatomy in University-college. 68 *Torrington-square.*
1831. Apr. 21.	Shee, Sir Martin Archer, Knt. President of the Royal Academy. 32 *Cavendish-square.*
1830. April 1.	Sheepshanks, Rev. Richard. M.A. F.G.S. F.R.A.S. 14 *London-road, Reading.*
1824. Mar. 11.	Shuckburgh, Sir Francis, Bart. *Pavilion, Hans-place, Chelsea; and Shuckburgh-park, Warwickshire.*
1841. Mar. 4.	† Sievier, Robert William, Esq. 12 *Henrietta-street, Cavendish-square.*
1813. Mar. 11.	Simmons, Richard, Esq. F.S.A. F.L.S. 3 *Cumberland-place, Regent's-park.*
1837. Apr. 20.	† Skey, Frederic C., Esq. 14 *Charterhouse-square.*
1820. Mar. 23.	Sleath, Rev. John, D.D. F.S.A. 4 *Hertford-street, May-fair.*
1841. June 10.	Smee, Alfred, Esq. 7 *Finsbury-circus.*
1825. May 5.	Smirnove, John, Esq. F.L.S. Soc. Cæs. Nat. Cur. Mosc. Socius. 41 *Wigmore-street.*
1824. May 14.	Smith, Lieut.-Col. Charles Hamilton. *Plymouth.*
1830. Dec. 23.	Smith, James, Esq. F.R.S.E. *Jordan-hill, near Glasgow.*
1837. June 1.	Smith, John T., Esq. Captain, Madras Engineers. *Madras.*
1840. Jan. 9.	† Smith, John Pye, D.D. *Homerton, Middlesex.*
1803. May 10.	Smith, John Spenser, Esq. F.S.A. *Caen, Normandy.*
1819. Nov. 25.	Smith, Joseph, Esq. F.L.S. 1 *Field-court, Gray's-inn.*

Date of Election.		
1806. Feb. 13.		Smith, Sir William, Knt.
1841. Nov. 18.	†	Smith, Sir J. M. Frederic, Lieut.-Colonel, Royal Engineers. *Chatham.*
1826. June 15.		Smyth, William Henry, Esq. Captain in the Royal Navy, K.S.F. D.C.L. Hon. M.R.I.A. F.S.A. For. Sec. R.A.S.—Instit. Reg. Sc. Paris. Corresp. Acadd. Sc. Neap., et Panorm. Flor., Socius. National Inst. Washington and Naval Lyceum of New York. 2 *Cheyne-walk, Chelsea.*
1807. May 7.	*	Solly, Richard Horsman, Esq. M.A. F.S.A. F.L.S. F.G.S. 48 *Great Ormond-street.*
1812. May 14.		Solly, Samuel, Esq. 48 *Upper Gower-street; and Poole, Dorset.*
1837. Jan. 19.	†	Solly, Samuel, Esq. 1 *St. Helen's-place, Bishopsgate-street.*
1823. May 29.		Solly, Samuel Reynolds, Esq. M.A. F.S.A. F.G.S. *Surge-hill, King's Langley, Herts.*
1797. Mar. 9.		Somerset, Edward Adolphus, Duke of, K.G. D.C.L. F.S.A. F.L.S. *Park-lane.*
1817. Dec. 11.		Somerville, William, M.D. F.R.S.E. F.L.S. F.G.S.
1821. Feb. 15.		South, Sir James, Knt. F.R.S.E. Hon. M.R.I.A. F.L.S. F.R.A.S. Acad. Imp. Sc. Petrop. Socius.—Acad. Reg. Sc. Brux. Corresp. *The Observatory, Camden-hill, Kensington.*
1825. Apr. 14.		Southey, Henry Herbert, M.D. Coll. Reg. Med. Socius. 1 *Harley-street.*
1812. May 28.		Speer, William, Esq. F.S.A. *Great Queen-street, Westminster.*
1834. Apr. 10.	†	Spence, William, Esq. F.L.S. *Liverpool.*
1807. Jan. 8.	*	Stanhope, Philip Henry, Earl. 20 *Charles-street, Berkeley-square; and Chevening-place, Kent.*
1816. June 27.		Stanhope, John Spencer, Esq. Instit. Reg. Sc. Paris. Corresp.
1830. Mar. 11.		Stanley, Edward, Esq. 12 *Lincoln's-inn-fields.*
1790. Apr. 29.		Stanley, John Thomas, Lord, F.S.A. 40 *Dover-street, Piccadilly.*
1842. Mar. 3.	†	Stanley, Owen, Esq. Captain in the Royal Navy.
1803. Apr. 28.		Staunton, Sir George Thomas, Bart. D.C.L. M.P. F.S.A. F.L.S. 17 *Devonshire-street, Portland-place.*
1832. April 5.	†	Stephens, Archibald John, Esq. M.A. 61 *Chancery-lane; and* 43 *Torrington-square.*
1829. Jan. 15.		Steuart, John Robert, Esq. M.R.A.S. 56 *North Frederick-street, Edinburgh.*
1811. Nov. 21.		Stevenson, William Ford, Esq. F.S.A. *Grande-rue, Passy, near Paris.*
1838. May 3.		Stirling, Edward Hamilton, Esq. *Calcutta.*
1821. Jan. 18.		Stokes, Charles, Esq. F.S.A. F.L.S. F.G.S. F.R.A.S. 4 *Verulam-buildings, Gray's-inn.*
1823. Nov. 27.		Storey, Anthony Mervin Reeve, Esq. M.A. 85 *Jermyn-street; and Glanusk, Brecon.*
1810. June 7.		Stracey, Sir Edward, Bart. LL.D. *Rackheath-hall, Norfolk.*
1825. Feb. 3.		Strangford, Percy Clinton Sydney, Viscount, G.C.B. G.C.H. D.C.L. F.S.A. 68 *Harley-street.*
1821. Mar. 8.		Strangways, Hon. William Thomas Horner Fox. 31 *Old Burlington-street; and Abbotsbury, Dorsetshire.*
1832. June 7.	†	Stratford, William Samuel, Esq. Lieutenant in the Royal Navy, F.R.A.S. Superintendent of the Nautical Almanac. 3 *Verulam-buildings, Gray's-inn; and* 6 *Notting-hill-square, Kensington.*
1807. Feb. 5.		Stratton, George Frederick, Esq. LL.D. F.S.A. *Tew-park, Deddington.*
1796. Nov. 17.		Sumner, George Holme, Esq. F.S.A. *Hatchlands, Guildford, Surrey.*
1828. Mar. 13.		Sutherland, Alexander Robert, M.D. F.G.S. 1 *Parliament-street; and Hermitage, Brompton.*
1820. Dec. 14.		Swainson, William, Esq. F.L.S. Soc. Hist. Nov.-Ebor. Socius.—Soc. Hist. Nat. Paris. Corresp. *New Zealand.*

Date of Election.	
1818. Feb. 26.	Swinburne, Sir John Edward, Bart. F.S.A. 18 *Grosvenor-place.*
1839. Mar. 14.	† Swanston, Clement Tudway, Esq. F.S.A. 51 *Chancery-lane.*
1834. Feb. 6.	† Sykes, Lieut.-Colonel William Henry. Hon. M.R.I.A. F.L.S. F.G.S. M.R.A.S. 47 *Albion-street, Hyde-park.*
1839. Apr. 25.	† Sylvester, James Joseph, Esq. F.R.A.S. Professor of Mathematics in the University of Virginia, United States.
1835. June 4.	† Symonds, Sir William, K.H. Captain in the Royal Navy. 4 *Somerset-place.*
1813. May 6.	Talbot, Charles Chetwynd, Earl, K.P. F.S.A. 71 *Grosvenor-street; and Ingestrie-hall, near Stafford.*
1831. Mar. 17.	Talbot, Christopher Rice Mansel, Esq. M.P. *Margam, Glamorganshire.*
1831. Mar. 17.	Talbot, William Henry Fox, Esq. 31 *Sackville-street; and Lacock-abbey, near Chippenham.*
1835. Feb. 5.	† Tattam, Rev. Henry, M.A. M.R.S.L. *Bedford.*
1825. May 5.	Taylor, John, Esq. Treas. G.S. 12 *Bedford-row.*
1842. Feb. 10.	Taylor, Thomas Glanville, Esq. F.R.A.S. Astronomer to the East India Company. *Madras.*
1836. Jan. 21.	† Taylor, Rev. William. *York.*
1834. June 5.	Teignmouth, Charles John, Lord, D.C.L. 19 *Portland-place.*
1829. Feb. 19.	Tennyson d'Eyncourt, Right Hon. Charles, M.P. F.S.A. 5 *Albemarle-street.*
1833. Dec. 5.	Terry, Charles, Esq. F.S.A.
1806. Jan. 16.	Thomas, Honoratus Leigh, Esq. 12 *Leicester-place.*
1828. Nov. 20.	Thompson, Lieut.-Colonel Thomas Perronet, M.A. *North-end, Hampstead.*
1821. Dec. 20.	Thomson, James, Esq. *Primrose, near Clitheroe.*
1824. June 3.	Thomson, John, M.D. F.R.S.E. *Edinburgh.*
1811. Mar. 28.	Thomson, Thomas, M.D., Regius Professor of Chemistry, Glasgow, Hon. M.R.I.A. F.R.S.E. F.L.S. F.G.S. *Glasgow.*
1810. June 7.	Thornton, Right Hon. Edward, G.C.B. *Wembury-house, Plymouth.*
1834. Apr. 10.	† Thornton, Henry Sykes, Esq. M.A. *Battersea-rise, Surrey.*
1839. May 30.	† Thorp, The Venerable Charles, D.D. Archdeacon of Durham and Warden of the University of Durham. *Durham.*
1841. Feb. 25.	† Tierney, Rev. Mark Aloysius. *Arundel, Sussex.*
1793. Apr. 18.	Tighe, Robert Stearne, Esq. F.S.A.
1835. April 2.	Tite, William, Esq. F.S.A. 25 *Upper Bedford-place.*
1838. Feb. 8.	† Todd, Robert Bently, M.D. Professor of Physiology and General Anatomy, King's-college, London. 26 *Parliament-street.*
1821. Mar. 22.	Tooke, Thomas, Esq. 31 *Spring-gardens.*
1818. Mar. 12.	Tooke, William, Esq. M.R.S.L. 12 *Russell-square.*
1818. Dec. 17.	* Torrens, Lieut.-Colonel Robert. *Reform Club, Pall-Mall.*
1812. Dec. 17.	* Towneley, Peregrine Edward, Esq. Trust. Brit. Mus. F.S.A. 7 *Park-street, Westminster; and Towneley-hall, near Burnley, Lancashire.*
1822. Nov. 7.	Townley, George, Esq. 5 *L, Albany.*
1842. Mar. 10.	Toynbee, Joseph, Esq. 12 *Argyll-place.*
1823. May 29.	Traherne, Rev. John Montgomery, M.A. F.S.A. F.L.S. F.G.S. *St. Hilary, near Cowbridge, Glamorganshire.*
1815. Nov. 16.	Travers, Benjamin, Esq. 12 *Bruton-street.*

Date of Election.	
1822. Nov 14.	Tulk, Charles Augustus, Esq. F.S.A. 19 *Duke-street, Westminster.*
1835. Feb. 5.	† Tupper, Martin, Esq. F.G.S. 5 *New Burlington-street.*
1817. June 5.	Turnbull, Peter Evan, Esq. F.S.A.
1831. Mar. 17.	Turnbull, Rev. Thomas Smith, M.A. F.G.S. *Caius-college, Cambridge.*
1821. May 24.	Turner, Charles Hampden, Esq. F.L.S. F.G.S. *Rook's-nest-park, Godstone, Surrey.*
1802. Dec. 9.	Turner, Dawson, Esq. Hon. M.R.I.A. F.S.A. F.L.S. M.R.S.L. Acadd. Cæs. Nat. Cur. et Reg. Sc. Holm. Socius. *Athenæum; and Yarmouth.*
1815. Dec. 21.	Turner, Samuel, Esq. *Liverpool.*
1839. May 9.	† Turnor, Rev. Charles, M.A. F.S.A. F.R.A.S. *Cheltenham.*
1838. April 5.	† Tuson, Edward William, Esq. F.L.S. 10 *Bedford-place, Fitzroy-square.*
1838. Feb. 8.	† Tweedie, Alexander, M.D. 30 *Montague-place, Bedford-square.*
1834. June 5.	Twining, Richard, Esq. 13 *Bedford-place, Russell-square.*
1838. Mar. 15.	† Twiss, Travers, Esq. D.C.L. F.G.S. Professor of Political Economy in the University of Oxford.
1820. Apr. 13.	Tylden, Lieut.-Colonel Sir John Maxwell, Knt. *Milsted, Kent.*
1821. Dec. 13.	Ure, Andrew, M.D. F.R.A.S. 13 *Charlotte-street, Bedford-square.*
1813. June 24.	Vaughan, William, Esq. F.L.S. F.R.A.S. 70 *Fenchurch-street.*
1830. May 6.	Vetch, Captain James. 1 *Clifford's-inn, Chancery-lane.*
1823. Jan. 9.	Vivian, John Henry, Esq. F.G.S. 24 *St. James's-place; and Swansea, Glamorganshire.*
1826. June 8.	Vyvyan, Sir Richard Rawlinson, Bart. *Trelowarren, Cornwall.*
1828. Apr. 17.	Walker, James, Esq. F.R.S.E. President of the Institution of Civil Engineers. 23 *Great George-street, Westminster.*
1831. Mar. 3.	Walker, Rev. Robert, M.A. Reader in Experimental Philosophy in the University of Oxford. *Wadham-college, Oxford.*
1830. April 1.	Wall, Charles Baring, Esq. M.A. M.P. F.S.A. M.R.S.L. 44 *Berkeley-square; and Normancourt, near Stockbridge, Hampshire.*
1829. Mar. 12.	Wallich, Nathaniel, M. et Ph. D. F.R.S.E. F.L.S. F.G.S. M.R.A.S. Instit. Reg. Sc. Paris., et Acad. Reg. Sc. Berolin., Corresp.—Soc. Reg. Sc. Hafn. Socius. *India.*
1819. Nov. 11.	Walter, Rev. Henry, B.D. *Hasilbury Brian, Dorsetshire.*
1837. May 25.	† Walton, Rev. William, M.A. *Allenheads, Northumberland.*
1809. Feb. 16.	Warburton, Henry, Esq. M.A. V.P.G.S. 45 *Cadogan-place, Sloane-street.*
1834. Apr. 10.	Warburton, John, M.D. Coll. Reg. Med. Socius 23 *Park-crescent, Regent's-park.*
1817. May 1.	Warre, John Ashley, Esq. 7 *Belgrave-square.*
1830. Dec. 9.	Warren, Rev. John, M.A. *Graveley, Cambridgeshire.*
1835. April 2.	† Warren, Samuel, Esq. *Inner Temple; and* 35 *Woburn-place.*
1815. June 8.	Warrender, Right Hon. Sir George, Bart. F.R.S.E.
1834. Feb. 6.	† Waterhouse, John, jun. Esq. *Halifax, Yorkshire.*
1818. Nov. 12.	Watson, Sir Frederick Beilby, K.C.H. F.S.A. 4 *Albany-terrace, New-road.*
1820. Dec. 7.	Watt, James, Esq. *Aston-hall, Birmingham.*
1827. May 24.	† Wavell, Major-General Arthur Goodall, K.F. K.C.S. *Little Lombone, near Stockbridge, Hants.*
1826. Mar. 9.	Weaver, Thomas, Esq. M.R.I.A. F.G.S. 16 *Stafford-row, Pimlico; and Woodlands, Wrington.*
1822. Mar. 21.	Webb, Frederick, Esq. F.S.A. *Langham-place, Brighton.*
1837. May 25.	† Westmacott, Richard, Esq. F.G.S. 21 *Wilton-place, Belgrave-square.*

Date of Election.	
1841. June 10.	† Westminster, K.G. Robert Grosvenor, Marquis of. 33 *Upper Grosvenor-street; and Eaton-park, Chester.*
1824. Dec. 16.	Wetherell, Sir Charles, Knt. D.C.L. 5 *Stone-buildings, Lincoln's-inn.*
1814. June 9.	Weyland, John, Esq. 52 *Charles-street, Berkeley-square; and Woodrising-hall, Norfolk.*
1840. Jan. 9.	Whatman, James, jun. Esq. *Vinters, near Maidstone, Kent.*
1836. Jan. 21.	† Wheatstone, Charles, Esq. Professor of Experimental Philosophy, King's-college, London. 20 *Conduit-street.*
1820. Apr. 13.	Whewell, Rev. William, D.D. Hon. M.R.I.A. F.S.A. F.G.S. F.R.A.S. Master of Trinity-college, Cambridge. *The Lodge, Cambridge.*
1837. Apr. 13.	† White, William Archibald Armstrong, Esq. F.S.A. 14 *College-street, Westminster.*
1835. April 2.	† Wigram, Hon. Sir James, Knt. M.A. F.S.A. 68 *Portland-place.*
1821. Mar. 8.	Wilbraham, George, Esq. *Delamere-house, Northwich, Cheshire.*
1834. Dec. 18.	Wilkinson, Sir John Gardner, Knt. 34 *Conduit-street.*
1835. April 2.	† Williams, Charles J. B., M.D. Professor of Physic in University-college, London. 7 *Holles-street, Cavendish-square.*
1828. Mar. 6.	Williams, John, jun. Esq. F.L.S. *Scorrier-house, near Redruth, Cornwall.*
1830. Apr. 22.	Willis, Rev. Robert, M.A. F.G.S. Jacksonian Professor of Natural and Experimental Philosophy, *Cambridge.*
1812. May 7.	Wilmot, Sir John Eardley Eardley, Bart. D.C.L. M.P. F.S.A. F.L.S. *Athenæum; and Berkswell-park, near Coventry.*
1838. Mar. 1.	† Wilson, Alexander, Esq. 34 *Bryanstone-square.*
1801. Apr. 16.	Wilson, Sir Giffin, Knt. 2 *Stratford-place; and Woburn-house, Beaconsfield, Buckinghamshire.*
1796. Apr. 28.	Wilson, Glocester, Esq. *Hastings.*
1834. Apr. 10.	Wilson, Horace Hayman, Esq. M.R.A.S. Boden Professor of Sanscrit in the University of Oxford. 6 *York-place, Portman-square.*
1831. Feb. 24.	Wilson, Sir Isaac, Knt. M.D. F.R.S.E. *High-street, Fareham, Hants.*
1834. June 5.	Witt, George, M.D. *Bedford.*
1813. Feb. 25.	Wix, Rev. Samuel, M.A. F.S.A. *Rectory-house, St. Bartholomew's the Less.*
1810. July 12.	Wix, William, Esq. *Tunbridge-wells, Kent.*
1829. Feb. 26.	Wollaston, Alexander Luard, Esq. M.B. F.R.A.S.
1812. Dec. 24.	* Wood, William, Esq. F.L.S. *Ruislip, near Uxbridge.*
1836. Dec. 22.	† Wood, William Page, Esq. 2 *Stone-buildings, Lincoln's-inn.*
1841. May 20.	† Wood, Lieut.-Colonel, Thomas, M.P. 4 *Cavendish-square.*
1841. Apr. 29.	† Woodward, Charles, Esq. 10 *Compton-terrace, Isliugton.*
1829. June 4.	Wortley, Hon. John Stuart, B.A. M.P. 15 *Curzon-street, May-fair.*
1804. Nov. 15.	Wrangham, Francis, M.A. Archdeacon of Cleveland. *Chester.*
1841. Apr. 29.	† Wrottesley, John, Lord, President of the Royal Astronomical Society. 13 *George-street, Hanover-square; and Wrottesley-hall, Wolverhampton.*
1839. Jan. 31.	† Yates, James, Esq. M.A. F.G.S. 49 *Upper Bedford-place.*

FOREIGN MEMBERS.

Louis Agassiz	*Neufchatel.*	1838.
François-Jean-Dominique Arago	*Paris.*	1818.
Elie de Beaumont	*Paris.*	1835.
Antoine César Becquerel	*Paris.*	1837.
Jens Jacob Berzelius	*Stockholm.*	1813.
Friedrich Wilhelm Bessel	*Königsberg.*	1825.
Jean-Baptiste Biot	*Paris.*	1815.
H. M. Ducrotay de Blainville	*Paris.*	1832.
Alexis Bouvard	*Paris.*	1826.
Alexandre Brongniart	*Paris.*	1815.
Leopold von Buch	*Berlin.*	1828.
Francesco Carlini	*Milan.*	1832.
Le comte de Cassini	*Paris.*	1789.
Augustin-Louis Cauchy	*Paris.*	1832.
Michel-Eugène Chevreul	*Paris.*	1826.
Le baron de Damoiseau	*Paris.*	1832.
Jean Baptiste Dumas	*Paris.*	1840.
Christian Gottfried Ehrenberg	*Berlin.*	1837.
Johann Friedrich Encke	*Berlin.*	1825.
Paul Erman	*Berlin.*	1827.
P. Flourens	*Paris.*	1835.
Karl Friedrich Gauss	*Göttingen.*	1804.
P. A. Hansen	*Seeberg.*	1835.
Christopher Hansteen	*Christiana.*	1839.
Baron Alexander von Humboldt.	*Berlin.*	1815.
C. G. J. Jacobi	*Königsberg.*	1833.
Admiral A. J. von Krusenstern.	*St. Petersburgh.*	1837.
Justus Liebig	*Giessen.*	1840.
Baron von Lindenau	*Dresden.*	1833.
Henry Frederic Link	*Berlin.*	1842.
Joseph-Louis Gay-Lussac	*Paris.*	1815.
Carl. Fried. Philip von Martius	*Munich.*	1838.
Macédonie Melloni	*Parma.*	1839.
C. F. Brisseau Mirbel	*Paris.*	1837.
Eilert Mitscherlich	*Berlin.*	1828.
Johann Müller	*Berlin.*	1840.
Jens Christian-Oersted	*Copenhagen.*	1821.
George Simon Ohm	*Nuremberg.*	1842.
Giovanni Plana	*Turin.*	1827.
Jean Victor Poncelet	*Paris.*	1842.
G. de Pontécoulant	*Paris.*	1833.
Lambert Adolphe Jacques Quetelet	*Brussels.*	1839.
Henry Rose	*Berlin.*	1842.
O. A. Rosenberger	*Halle.*	1835.
Théodore de Saussure	*Geneva.*	1820.
Heinrich Christian Schumacher	*Altona.*	1821.
Friedrich Georg Wilhelm Struve	*Dorpat.*	1827.
Jacques Charles François Sturm.	*Paris.*	1840.
Friedrich Tiedemann	*Heidelberg.*	1832.
Le baron Thénard	*Paris.*	1824.

FELLOWS DECEASED SINCE THE LAST ANNIVERSARY (Nov. 30, 1841.)

On the Home List.

Sir William Beatty, Knt. M.D.
Sir Charles Bell, Knt.
Thomas Blizard, Esq.
Lieut.-Colonel Sir Alexander Burnes, Knt.
Sir William Burroughs, Bart.
Richard Hart Davis, Esq.
Joseph Delafield, Esq.
John Dickenson, Esq.
The Right Hon. Sir William Garrow, Knt.
Lord Francis Gray.
Francis George Hare, Esq.
† Henry Hennell, Esq.
Sir Henry Hugh Hoare, Bart.
* James Ivory, Esq. K.H. M.A.
Joseph Jekyll, Esq. M.A.
Aylmer Bourke Lambert, Esq.
The Earl of Macclesfield.
The Earl of Munster.
The Duke of Norfolk.
John Gage Rokewode, Esq.
† Samuel Seaward, Esq.
† Henry Harper Spry, Esq.
† Lord Vivian.
† Lieut. J. R. Wellsted, I.N.
John Yelloly, M.D.

Ejected.

William John Bankes, Esq.

FELLOWS ADMITTED SINCE THE LAST ANNIVERSARY (Nov. 30, 1841.)

On the Home List.

Date of Election.	
1841. Nov. 18.	† Allen, Captain William, R.N.
1842. Jan. 13.	† Baily, Edward Hodges, Esq.
1841. Dec. 16.	† Bennett, John Joseph, Esq.
1842. Nov. 17.	Bowerbank, James Scott, Esq.
1842. Feb. 17.	† Broughton, Robert Edwards, Esq.
1842. May 26.	Chapman, Thomas, Esq.
1842. Apr. 14.	† Christmas, Rev. Henry, M.A.
1841. May 27.	Cursetjee, Ardaseer, Esq.
1842. Jan. 13.	† Donkin, William Fishburn, Esq. M.A.
1842. May 5.	† Fielding, George Hunsley, M.D.

Date of Election.	
1842. May 5.	† Jesse, John, Esq.
1842. Mar. 10.	† Johnson, Cuthbert William, Esq.
1841. Nov. 25.	† Lovelace, The Right Hon. the Earl of.
1842. Mar. 3.	† Morison, Major-General William, C.B.
1842. Jan. 6.	Newbold, Lieut. Thos. John, Esq. E.I.C.S.
1842. Jan. 27.	† Pratt, Samuel Peace, Esq.
1842. Jan. 13.	Riddell, C.J. Buchanan, Esq. Lieut. R.A.
1842. Mar. 3.	† Stanley, Captain Owen, R.N.
1842. Feb. 10.	Taylor, Thomas Glanville, Esq.
1842. Mar. 10.	Toynbee, Joseph, Esq.

On the Foreign List.

HIS MAJESTY FREDERICK WILLIAM IV. KING OF PRUSSIA.

Henry Frederic Link.
Dr. George Simon Ohm.
Jean Victor Poncelet
Henry Rose.

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